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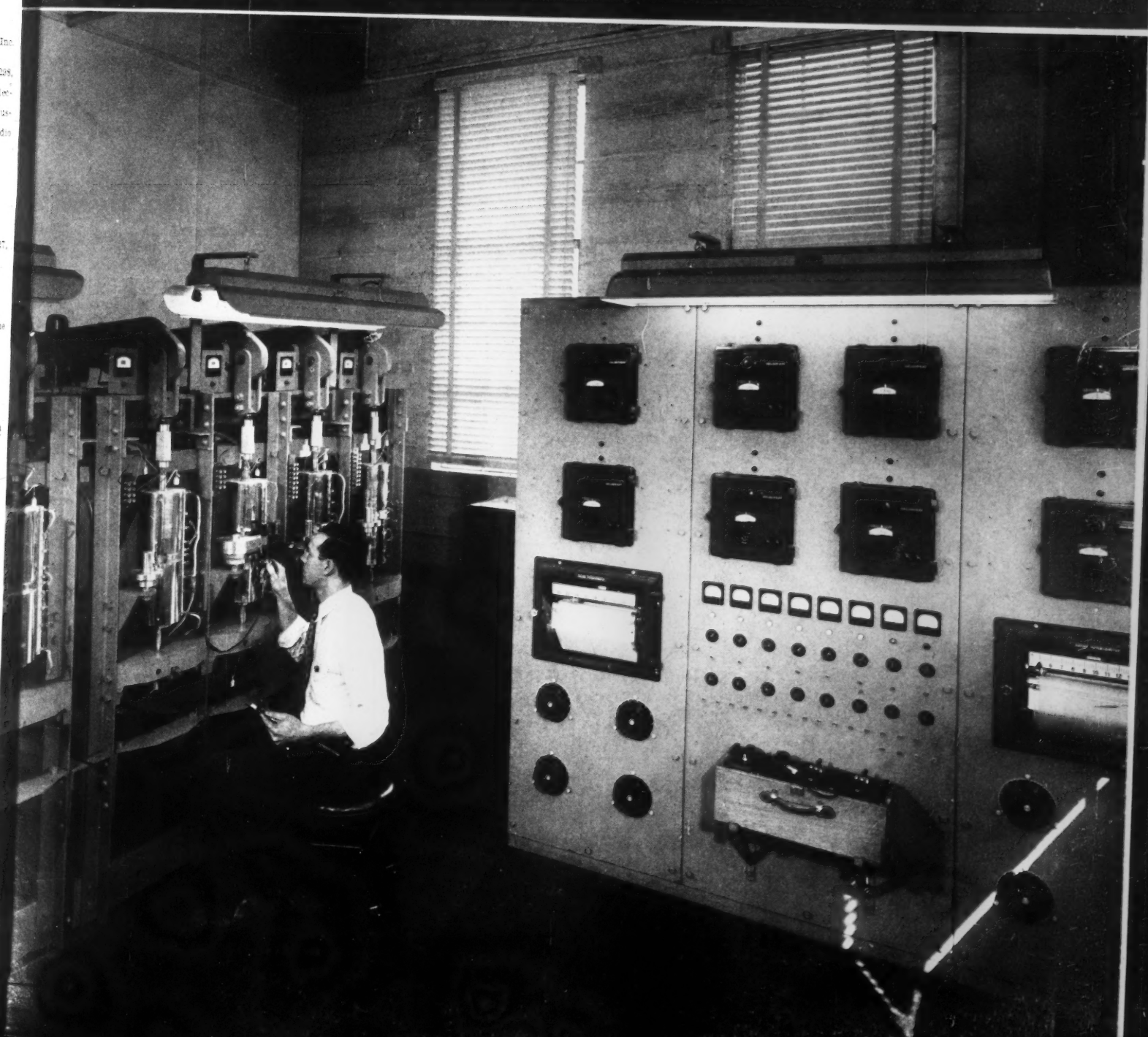
Instruments

THE MAGAZINE OF Measurement and Control



BAROMETERS
Mercurial

CONTROLLERS
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Humidity
pH
Liquid Level
Pressure
Temperature
Vacuum

FLOW INSTRUMENTS
Controllers
Indicators
Integrators
Meters
Recorders

GAGES, RECORDING
Pressure
Temperature
Vacuum

HYDROMETERS

HYGROMETERS
Wet & Dry Bulb
Thermometers

LIQUID LEVEL
Controllers
Indicators
Recorders

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Mercurial Vacuum

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Wood, Granular
Material

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Controlling
Indicating
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PYROMETERS
Controlling
Indicating
Recording
Resistance
Thermoelectric

RECORDERS
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Humidity
pH
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Bulletin V-105, issued by the Merco Nordstrom Valve Company, Pittsburgh 8, Pennsylvania, contains complete information on the proper lubrication of pressure lubricated valves.

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FIRST IN SILICONES

Instruments
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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Is "Good Enough" Really Good Enough?

A Guest Editorial

By PAUL G. WEILLER

MANY of our most important technical advances have been due to the stimulus of war.

The First World War gave us radio. It was an appropriation of one-half million dollars by the United States Navy which triggered off the tremendous development of radio and electronics of the post-war years.

Before the Second World War, the airplane seemed to be good enough for civilian transportation but it was not good enough for war uses. Consequently, tremendous pressure was brought upon engineers and manufacturers towards further improvements. The result was the giant plane of today with improved instruments, automatic pilots, anti-collision radar, navigation radar and many other instrumentation units.

On the other hand, a great quantity of keenly needed improvements were hardly touched by war activity. May we hope for substantial improvements in these devices during peace-time?

I am wondering, for instance, why no one ever took the trouble to design a relay to operate with maximum effectiveness in connection with existing vacuum tubes. Or why no one attempted to design a vacuum tube which will operate efficiently with a relay of reasonable design. Neither of these two items is available in the open market today.

Our instruments and control devices are becoming more and more electrical. It is only logical to control an electrically-operated valve by an instrument with an electrical output. Still, the only electrical valve operators of any importance are clumsy gear-reduction affairs driven by a motor, the speed of which cannot be varied. Why does no one design an electro-hydraulic valve operator which would be ever so much more convenient and flexible?

Recently, operators of this type have been used to position the control surfaces of airplanes with great success. They were war planes, of course. Why not try a little of the same thing on valves for peace-time uses?

An electronic instrument with interchangeable primary elements for temperature, pressure and level would not be too far-fetched a dream with our present knowledge of such matters. Does anyone intend to make and market such a device?

Millions of miniature motors have been used on planes, fire controls and other war devices (price no object). Some were d.c.; others were a.c. for 60-, 400-, and 800-cycle frequencies.

Instrument-makers and makers of control devices have been crying for such motors for a long while. Now they are here but only at fancy prices.

The reason for the high prices is not, as one might think, the greed of the seller but the method by which such motors are produced. The rotor of a miniature motor, particularly if it is a squirrel cage motor, can be made very cheaply.

The stator, however, offers a winding problem of the first order. Most manufacturers wind stators by hand. This means jockeying fine wire coils into the stator slots almost a wire at a time. This job takes an entire shift, more or less, if the winder is highly skilled. Anyone familiar with present wage and overhead rates can figure the cost.

I have been told that one manufacturer has developed a machine to wind the stators automatically but, of course, one swallow does not make a summer: there is little or no effect on prices of miniature motors.

Here is a worth-while task for the engineers of some manufacturer: to either devise an automatic machine to do the job or to change the design of the motor so that the winding becomes an easy procedure. The old way just does not seem good enough.

Mercury switches have been on the market for some quarter of a century or thereabouts. For many years, they were timidly recommended only for household devices where their malfunctioning could not do much harm. Much later, they were adapted to instruments. A few years ago, a few makers attempted an ambitious design with a metal shell. The maximum load has increased from a faint-hearted 5 amperes to some 200 amperes.

Applications are many but still a bit marginal. Those familiar with the art know that the mercury switch has some characteristics which make it an almost ideal current-breaking device. It is comparatively noiseless; develops very little heat; deterioration of contact-making parts is at a minimum. Mercury switches are explosion-proof.

Has no one the courage to take the step from 200 amperes to 2000 amperes; from crude tilting or displacement switches to a design with a positively-operating mechanical arrangement?

If mercury pool tubes can carry hundreds or thousands of amperes, cannot mercury switches also be made to rupture hundreds or thousands of amperes just as silently and smoothly?

And as we have arrived at the subject of arcing, will anyone make a thorough study of arcing phenomena so that we will know what happens when heavy currents are broken; so that we can design efficient switchgear on a solid foundation of knowledge instead of by-guess-and-by-gosh and by experience? And then, will anyone trouble to find out why some contact materials have a much longer life than good old plain silver?

Now it is quite possible that some of these problems or all of them have been thoroughly worked out. Perhaps the knowledge is taking up space in someone's files and the up-to-date designs are resting in a blueprint vault. At any rate, there is potential knowledge in this field that cannot be found in the literature and there are certainly many, many practical devices not yet available to the purchaser.

Anything is good enough when we have nothing better—but is it really good enough?

The Brighter Side

INSPIRING as are Dr. Weiller's remarks, they might lead younger subscribers to think that research lags inexcusably in the fields he mentions. Your editor, though not an expert in these fields, can assert that a great deal of research has been completed *and published*. For example, on electric arcs, contacts, etc., about ten books and a thousand articles can be found in any large technical library: two years ago the ASTM listed 837, including 23 by Windred, 20 by Slepian, 26 by Holm, 22 by Suits and 10 by Cobine. There were 619 authors indexed to 1943. True it is that science knows not the "why" of arcs and contacts. But relays ARE getting better every year—as are most other products!

As for "an electronic instrument with interchangeable primary elements," we believe that makers of cathode-ray instruments can supply it—and various *non*-electronic instruments may well meet Dr. Weiller's requirements.—MFB

Electronics—Servant or Fad?

By PAUL G. WEILLER, Consulting Engineer, New York City

TO the question posed in the title there is a definite answer: Electronics may be either a servant or a fad—or both at the same time. I shall illustrate this point with three examples.

The first example is one with which all of you are familiar: the famous automatic doors in Pennsylvania Station, operated by photocells connected through an electronic amplifier to the door-operating mechanism. In this application, the electronic part of the operating device is only a small fraction of the dollar value of the entire installation. Besides, the doors could have been operated just as easily, or even better, by a plate let into the floor on which you walk. I should say that in this example electronics is a pure fad, successfully employed for sales promotion purposes. The electronic device in this application is used purely because of its sales appeal.

The second example is of a different nature. Some years ago, an engineer in Newark, New Jersey, claimed to specialize in electronic devices. In his travels he met with the management of a large soft-drink plant. Its product was packed in white, red and green bottles which had to be separated when they came back empty. The consulting engineer rejoiced. Here was a typical job for photocells and electron tubes, because there was no other type of equipment which would discriminate between various colored bottles.

"How much will this photocell unit cost?" asked the chief engineer. "Oh," said the consultant, "some $200 or $250." "Fine," was the answer, "let's go to it."

The chief and the consultant went up to the drafting room and figured out what had to be done to handle the bottles, separated by the photocells, to their respective storage bins. The answer was a $15,000 conveyor. Consequently, no sale!

This was, however, a perfectly logical application of photocells, but again, the photocell and electronic amplifier were only minor accessories to an expensive installation. In this example electronics is certainly a servant, but an expensive one. To employ its abilities, it became necessary to spend a great deal of money on non-electronic equipment.

The third example is characteristic of applications wherein an electronic device is a large part of the expense and where the same result cannot readily be obtained with non-electronic means. I refer to welding timers, one of which you see here on the floor.

Spot welding was invented in the nineties by Professor Elihu Thompson as a crude means of fabricating metal parts. It was used for kitchen utensils and in many other places where appearance, reliability and strength were not important. Recently, however, there was a revolution in spot welding. We began to use it for building trains, instruments and numerous highly-stressed metal parts which had to be absolutely reliable. Sometimes the weld had to be invisible, or nearly so. Spot welding was also applied to fancy metals like dural and stainless steel. These metals can be welded only with short-time current impulses — let us say, about one cycle, or 1/60 of a second. No mechanical devices will conveniently handle heavy welding currents where such short times are required.

The electronic welding timer was the first really important application of electronics to industry, and it now represents millions of dollars' worth of business every year.

Electronic timers do have some glass tubes, even if the large tubes handling the power currents are so-called metal tubes. At first it was difficult to sell superintendents and foremen on the use of any glass devices in a rough-and-tumble metal-working shop. The excellent performance of such devices, however, overcame the prejudice against glass within a few years, and now the industrial public has gone to the other extreme.

Electronics has become a catchword, and everybody and his girl are anxious to "go into electronics." This is well shown by experiences I have had recently.

I often meet men who are casting around for new fields of post-war activity. Some of them are not even technical men, but have had some connection with war production. One of them said: "I want to get into something really good for the future. Could I get into electronics?" I tried to explain to him that outside of the radio business there was no such thing as an electronics business. From what I have said so far, it must be clear to anyone that electronic devices are largely accessories to other equipment.

Electronic timers are of no earthly use by themselves. They are employed only to operate spot welders, although in some cases the timer is more expensive than the welder, and we have, in a way, the tail wagging the dog.

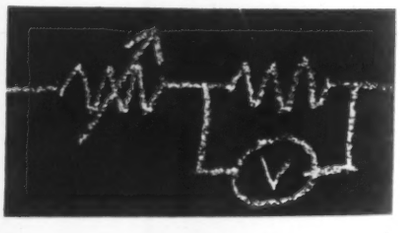
But now, bankers and bakers and candlestick makers all want to get into electronics. I know of one factory in Brooklyn which sold "genuine electronically-baked bread." I am not sure whether they are still in business now.

But suppose, for a moment, you are the vice-president in charge of engineering of an important corporation. Picture yourself sitting in a conference with the sales manager, the research director, the president and a few other bigwigs. The sales manager is all excited: your competitor the XYZ Company has gone into electronics, and he doesn't see how we can compete without glueing some electronic device to one of our products.

On the other side of you, the research director's eyes begin to sparkle. "Oh, yes," he says, "we should have done that long ago," and then he tries to tell you what wonderful things he has done with electronics, until your ears ring. So you are between the devil and the deep sea, and good advice is scarce.

What are you to do? If you dive into electronics and the product does not sell as the sales manager expects it to, you will be the goat. If you refuse to listen, you will be called stick-in-the-mud and you will be made responsible for anything untoward which might happen to sales.

It is my object this evening to give you at least a superficial idea of the general characteristics of electronic devices, their advantages and drawbacks. At the risk of boring the experts for a minute or two, I am going to start with the basic principle. In its simplest form, the electron tube has what we call a plate, a grid and a cathode. If the plate is connected to the positive terminal of a power supply of a few hundred volts and the cathode is connected to the negative terminal, the current will flow through the tube, its magnitude depending on the voltage difference between the grid and the cathode. Whether you have a single two-element tube, or a complicated amplifier with numerous tetrodes and pentodes, the operation is substantially the same. When you vary the voltage on the grid, the output current of the last tube will vary in proportion. I draw on the board a diagram



of two resistors in series, one variable and the other not; and now I add a voltmeter across the fixed resistor. Anyone with an elementary knowledge of things electrical will know that the voltage across the fixed resistor will vary whenever the resistance of the

*Presented before the New York Society for Measurement and Control, March 28, 1944; and before several other groups in 1944 and 1945.

variable resistor varies. While this diagram is not what engineers call the equivalent circuit of a vacuum tube, it nevertheless represents quite accurately the operation of a vacuum tube. Whether the tube has only one grid or five grids makes little difference in its basic functions.

Summary of Advantages and Disadvantages

Now we can proceed to discuss the advantages and disadvantages of the vacuum tube with the help of this diagram.

The first question we are going to ask ourselves is this—why use a vacuum tube when a variable resistor will do? The answer is simple and definite. To operate the slider of the variable resistor takes power. The grid circuit of a vacuum tube, which operates just like the slider, takes an infinitesimal amount of power. This is the Number One virtue of electronic devices. They take almost no power at the input or signal side; therefore, we can start or stop some heavy machinery by the power of a light beam impinging on a photocell.

Virtue Number Two is speed of operation. We can change the resistance of a vacuum tube a hundred million times per second without noticing any appreciable delay in its function. We are not using any such speeds in industrial measuring instruments or automatic controllers, but this virtue of vacuum-tube devices means that the electronic part of any control will follow the input signal without time delay. For ordinary purposes, we can say that while relays and other electromechanical controls take an appreciable time to operate, the vacuum tube is instantaneous, and therefore ideally adapted to control operations where high speed is important.

Which brings us to high-speed welding. Spot welds are now made at speeds of 600 welds a minute. There certainly is no mechanical device which would break currents, amounting to possibly 1000 amperes, 600 times a minute, without wearing out in a very short time.

These two advantages of vacuum-tube devices are so great that they overshadow their disadvantages, which are numerous. In the first place, inexpensive receiving tubes pass very little current: the largest one can handle less than 1/10 ampere. Therefore, at the end of a vacuum-tube device, there must be, as a rule, some relay or some small motor which operates the heavier controls required to handle large powers.

In electronics, there are important exceptions to almost every rule. One of these exceptions is the large mercury pool tube used in welding and as power rectifiers. One of the smallest types of such tubes is exemplified by the two tubes you see on this table.

Electronic devices are expensive. The reason is obvious when you compare a mechanical instrument like, for instance, a pressure gage, with an electronic control device consisting of the same number of parts. Instrument parts are made of metal. Most of them can be turned out by a punch press or some other automatic machine. Their cost is from a fraction of a cent to a few cents apiece.

In electronic devices, one of the cheapest items is the receiving tube. Its price runs from about 20¢ to roughly $1.00. A transformer coil might cost also from 20¢ to $1.00. As much can be said for capacitors, resistors and almost all radio components. We have replaced parts costing up to a few cents with parts costing ten times as much. This price ratio is inherent in the design of electronic components and little reduction in cost can be hoped for in the future.

> "The skill of the electronic engineer . . . starts with a thorough knowledge of materials and mechanical and electrical elements . . . It requires a knowledge of psychology . . .; a knowledge of the processes which have to be controlled . . ."

Consequently, the first thing to consider in comparing an electronic device with a purely mechanical device performing the same service is to decide whether the performance is sufficiently better to warrant the higher cost. This is a very important consideration.

You will probably ask me why you can buy a radio set for $10.00 when electronic devices are so expensive. The answer to this question is quite obvious to the engineer. Radios, even the good ones, are built with the worst quality components that will stand the gaff for a while. If "a condenser blows" in a radio set, you will be very much put out, but you will send for the service man and forget all about it. If an industrial electronic control goes haywire, you may wreck thousands of dollars' worth of machinery or spoil thousands of dollars' worth of products. Consequently, the components of electronic controls must be of far better quality, and are proportionately more expensive.

In addition to that, measuring instruments and automatic controls can never be sold in the quantities of inexpensive radio sets. Therefore, the overhead items are much higher.

Another disadvantage of electronic devices is their inherent inaccuracy. No two tubes you can buy are exactly alike by several percent. Their circuits must, therefore, be so designed that replacement of tubes do not seriously affect results. This is not always easy, and sometimes results in additional complication.

There are also certain factors of inaccuracy inherent in the function of vacuum tubes. Now, let me be guilty of some degree of exaggeration for a moment and let me tell you about the factors which may interfere with accuracy in the operation of the simplest vacuum tube in your radio set.

You often have some freak contact potentials between grid and cathode. These potentials or voltages may add to or subtract from your grid voltage. There are leakages on the surfaces of parts. There is conduction through ionization of the minute amounts of gas still present. There is a photoelectric effect of the light from the filament or heater impinging on the other electrodes. There are soft x-rays formed by the impinging of the electrons on the anode. There are the effects of changes in dimensions while the tube heats up, and a plethora of other troubles.

Another drawback is the effect of voltage variations on most electronic devices. There are some voltage regulators to be had, but most of them are relatively cumbersome and expensive. All those difficulties are not necessarily serious, but they have the effect of narrowing down the field of usefulness and of increasing the difficulty of arriving at a useful design.

The difficulties I have pointed out are serious at times in d-c. amplifiers but do not interfere so much with the operation of a-c. amplifiers. That is why it is almost impossible to use d-c. amplifiers in practical instruments and controls—again, of course, barring a few exceptions.

You see on the bench here a vacuum-tube voltmeter which includes a d-c. amplifier. The high stage of development of electronic devices would have been quite impossible without the use of vacuum-tube voltmeters. Nevertheless, even the best vacuum-tube voltmeter is only a makeshift when its operation is compared to that of an ordinary high-accuracy voltmeter.

"Bugs"

When you develop an electronic circuit, you do not stop to worry about x-rays and contact potentials or any other of the sources of inaccuracy which I have mentioned. But you always have to keep in mind that there are some factors in electronic devices which are difficult to control. These factors appear during development work. They are the so-called "bugs"—that is, peculiar quirks of the finished device which cause misoperation under some circumstances, unless they are corrected by supervisory elements. These latter are intended to prevent such misoperation. In this respect, the development engineer stands before a problem of rather considerable magnitude. These "bugs" cannot be predicted

or calculated. They can be found only by thorough and comprehensive tests. Just as negative proofs are always subject to doubt, so we never know whether we have eliminated all "bugs" out of an electronic device. Of course, the final proof of it is a prolonged field test under the most grueling conditions that can be found. This, of course, is still not an absolute proof that under some conditions some other "bugs" will not appear.

Here is an example.

When I was making and selling welding timers in commercial quantities, the following trouble appeared occasionally—I should say, rarely. The timer would make about 5,000 welds a day, two or three of which would be defective. It happened that these welds were made on some battleship parts weighing about a ton. The defective weld had to be patched by arc welding. Even the moving of a piece weighing a ton is an unpleasant business, particularly if it has to be turned several times to reach the defective welds. To find the cause of these rare misoperations was quite a problem. The only thing that could be done was to connect the welding timer to an oscillograph and operate it with an automatic switch. Then you had to sit there by the hour until the misoperation appeared. Finally, we found that the defect was due to the use of brass as a contact material in certain places where, offhand, there should have been no objection to using almost anything, as the currents were small and the voltages high.

What had happened was this. The microscopic spark formed at that place would cause capillary cavities similar to minute worm-holes in the brass. When there were a few of these worm-holes, the contacts would fail to function properly for reasons which I cannot account for. That seems to be far from electronics, but remember, sparks and arcs are decidedly electronic phenomena. After we had replaced brass as contact material with something better, the trouble disappeared, but it was certainly one of those things which could not be expected in advance.

This particular welding timer will serve as a good example of "bug chasing" in electronic devices. This timer is obsolete, or almost so, as there are only a few left in operation. Therefore, I can "tell all"—which is not true for many electronic devices nowadays!

This slide (Fig. 1) shows the basic circuit with all the details. The circuit is almost of elementary simplicity and, offhand, there should be no difficulty in making it operate properly. The tube is an ordinary triode, preferably a No. 56. Voltages are supplied by a conventional power-pack, the output of which is about 300 volts d.c. The position of a timing capacitor between grid and plate is somewhat unconventional. After trying all possible positions for this capacitor, best operation was found when it was in the place shown.

The grid, as you see, is operated by a single-pole double-throw blade, mechanically connected to one of the two contactors. When the large contactor is open, the blade connects the grid to the ground. Because of the arrangement of the voltage divider, the grid of the grid capacitor will make it a potential of about 100 or 150 volts, negative, in reference to the cathode. The tube is biased to cut-off, and the small timing relay is open.

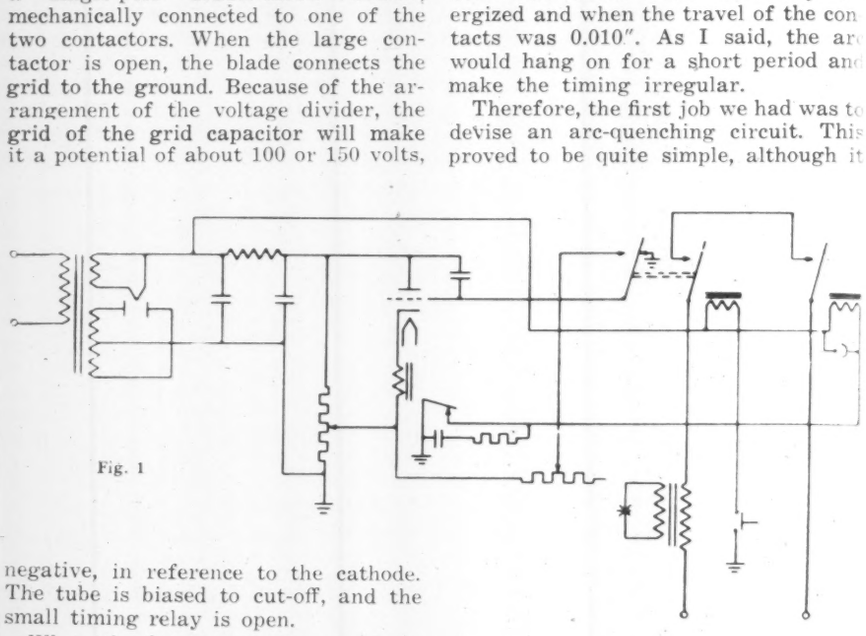


Fig. 1

When the large contactor operates, the blade connected to the grid is thrown to discharge. The timing capacitor discharges through the timing resistor and part of the voltage divider, until the negative bias on the grid is reduced to a point where the relay receives sufficient current to operate.

The second large contactor is connected to the back contact on the small timing relay. The operation of the relay will, therefore, cause it to drop out. You have two large contactors in series with a power line and the welder—one normally open, and the other normally closed. When the welder switch is closed, one contactor closes and thereby admits current to the welder. At the same time, the timing circuit is started. At the end of the time interval, the timing relay will operate and drop the other series contactor out, and thereby end the welding period.

You see that the closing operation and the opening operation are separated and allotted to two different contactors. This is done for a number of reasons which I will skip to save time. Suffice it to say that any short timing periods like one cycle or a few cycles cannot be obtained with any degree of accuracy with a single contactor.

You have now the basic theory of this contactor. It was designed with pencil and paper and none of the basic features in it has ever been changed. But does it work that way? Not by a long shot.

The first trouble we found—and that, of course, was to be expected—was that the relay breaking 300 volts d.c. with only 0.010" movement of the contact would not operate properly. By the way, we had found that this particular relay would give accurate timing only if the armature was hanging down so that gravity would help opening it, and if the spacing between armature and core was 0.006" with the relay energized and when the travel of the contacts was 0.010". As I said, the arc would hang on for a short period and make the timing irregular.

Therefore, the first job we had was to devise an arc-quenching circuit. This proved to be quite simple, although it took some time to find the best proportions. We found that a one-microfarad capacitor in series with an 80-ohm resistor connected around the contacts would serve two purposes: it would prevent an arc completely and thereby eliminate any effect of arc duration on accuracy of timing; secondly, it would reduce to a constant factor the sticking of contacts, which always must occur whenever minute currents are broken or made. As the relay is used in this circuit as a measuring element, any sticking of the contacts would, of course, add to the spring tension and thereby affect the current at which the relay will operate, and then, again, the timing.

So far, so good, but when this "bug" had been eliminated and the timer seemed to operate fairly well, we suddenly found sparks of considerable length breaking out all over the apparatus. What had happened was this: By using a spark-quenching circuit, the current through the contactor coil was broken within an exceedingly short time, thereby causing tremendous opening surges. From the length of the sparks, we calculated these surges must have been at least 5,000 volts—not very pretty in control instruments.

There we stood again before a major problem. It was solved by shunting the contactor coil with a tubular neon lamp which had to have a break-down potential of about 1000 volts. This was not so hard to obtain but, at the same time, the discharge had to extinguish itself at about 400 volts. This was necessary as the contactor coil was operated at 300 volts and it would have been detrimental to have the lamp draw current when the contactor was energized. To get lamps with both characteristics

was somewhat difficult, but Littelfuse Laboratories did a good job in developing a lamp which would do the job.

Now we thought we were on top of the world. The timer operated, although we had to use wire insulated for 2000 volts instead of the regular hook-up wire. This was made for us specially by the Western Electric Company.

Then we began checking the accuracy of timing. Well, sometimes it did and, sometimes again, it didn't. In tracing the trouble to its source, we found that the stopping pin which prevented the armature from making contact with the core had to be at least 1/16" high, and it had to be husky enough to stand the continuous battering. If the distance between the closed armature and the core was less than 1/16", the time constant of the circuit would be so high that one-cycle operation could not be obtained.

After these major "bugs" were taken care of, there were, of course, a lot of minor ones, but their elimination did not take very much time.

What you see on this slide (Fig. 1) is an extremely simple, straightforward circuit, and yet it required a considerable amount of fairly difficult development work to make it workable—and, at that, I have not spoken of the troubles we had on the contactors, arc extinguishing, and innumerable other troubles. That all of them were solved in a satisfactory manner was proved by the fact that about 300 of these timers were bought by various industries and some of them have operated day after day for some five to seven years.

Now, the strangest thing about it is that the relay, which everyone expected to give most of the trouble, has given almost none. This proves, incidentally, that even the application of relays is almost an art in itself.

Igniter Developments

What you have seen so far is a welding timer with electro-mechanical switching and electronic timing. This piece of equipment is quite effective, but for small welders its main virtue is its reasonable cost. When you have about fifty 10-kva. or 15- or 20-kva. welders in a plant—the welders costing anywhere from $200 to $400—you don't like to buy fifty fully-electronic timers at $1000 each.

The next slide (Fig. 2) shows a timer with electronic switching and mechanical timing. This device can be employed on welders up to the largest sizes. It does everything that a fully-electronic timer will do, and does it in a rather simple manner. Its main advantage over a fully-electronic timer is its comparative simplicity. Trouble-shooting on this timer can be taken care of by an intelligent maintenance man, while trouble-shooting in a fully-electronic timer requires an expert who has been trained to do the job.

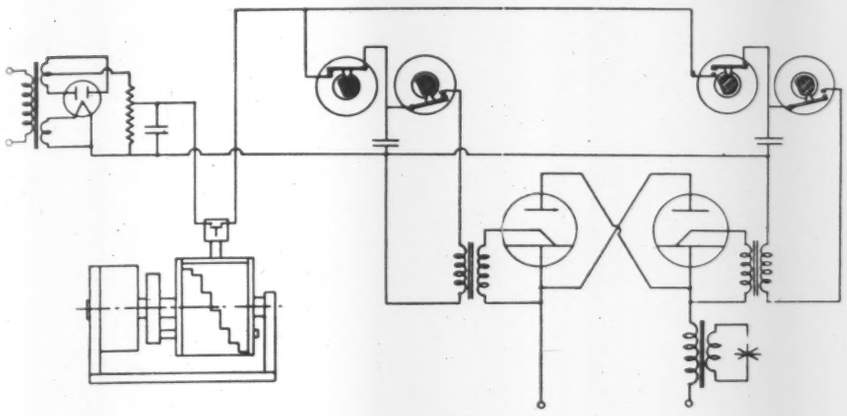


Fig. 2

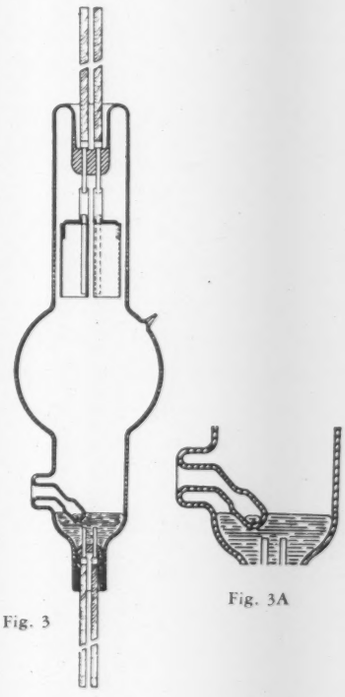


Fig. 3

Fig. 3A

The tubes are mercury pool tubes. (Fig. 3) You are all familiar with the old-style mercury pool rectifiers. Those rectifiers were ignited by tilting the tubes and making contact with an auxiliary electrode. This is, of course, not feasible for welding where we have to fire the tube once for each half cycle.

About twelve years ago Dr. Slepian at Westinghouse originated a firing system for mercury tubes consisting of a pencil of a high-resistance material immersed in the mercury. It has been developed commercially by both Westinghouse and General Electric. This ignition system, however, requires almost one full kilowatt for reliable ignition. Consequently, the control circuit which has to handle all this power becomes somewhat clumsy and expensive.

We have been successful in our effort to reduce the firing impulse from 1 kilowatt to, roughly, 5 watts. An additional 10 watts will take care of filaments and any other requirements of the timing circuit. Therefore, we have 15 watts against 1000.

To do this, we resorted to the oldest method of igniting for a mercury pool rectifier. In fact, this method is about forty years old. Some of you will remember that you can start such a rectifier by supplying a high-voltage impulse to a ring of tinfoil placed around the tube at the point where the meniscus of the mercury touches the glass. Why such a voltage impulse will ignite a mercury vapor rectifier was never very clear. Up to date, the most acceptable theory has been based on the high voltage gradients existing between the mercury and the glass at the place where the surface of the mercury forms a sharp angle with the vessel.

The high gradients certainly exist, but it is quite doubtful whether they have anything to do with ignition. The first electrons in this case would have to be formed by field emission, and that is a rather uncertain factor.

We have replaced the tinfoil ring by a well dipping into the mercury on the inside of the tube. This was done for a number of reasons. One of them was the tendency to corona effects when the igniter strip was placed on the outside of the bulb.

There was, of course, the usual lot of sweat and tears until we obtained completely reliable operation of these tubes. After we got that far, we were, however, itching to find out whether the old theory was correct.

For this purpose, we used as an igniter electrode a drop of mercury at the bottom of the well with a level considerably below the level of the mercury in the tube. [See Fig. 3A.] With this disposition of the electrode, there could be no question of voltage gradients in the vapor between the meniscus and the glass. Well, the tubes worked as well, or better, in this way. Consequently, the old theory was "busted" well enough, but we did not have a new one to replace it at the outset.

Close observation and consideration of things which had been published a long, long while ago brought to light a new theory which seems to be adequate to explain all the facts. And that,

after all, is the best you can expect of the best of theories.

If you dip a glass well into a pool of mercury and place an electrode inside the well, which electrode is connected to an alternating voltage, you will see ripples on the mercury which are accurately synchronized with the voltage you have placed on the electrode. You might have to use a stroboscope to see the waves, but they are undoubtedly there. This phenomenon is dubbed "capillary waves" and has been known for some time.

If you replace the alternating voltage by a series of sharp impulses, you will have one wave-train starting from the glass wall for each impulse. It is well-known that there are some substantial contact potentials between glass and mercury. As the glass is a poor conductor, the charges will accumulate near the glass surface approximately in the fashion of a capacitor with an almost infinitely thin dielectric. Consequently, even a potential difference of a few volts will cause a

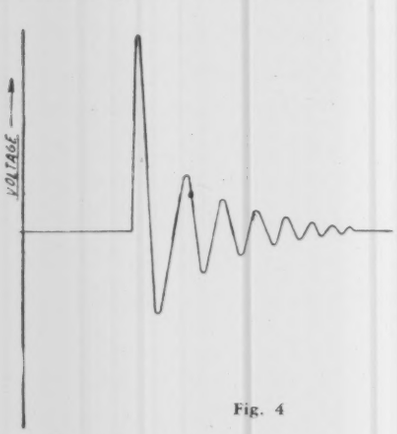


Fig. 4

substantial amount of energy to be trapped between the mercury and the glass.

If, now, the mercury moves away from the glass, this energy will be released. It has been measured by someone, and found to reach a potential of some 20,000 volts, which is more than sufficient to start the discharge in the mercury vapor.

Some of you may have seen a toy consisting of a small glass bulb filled with neon at a low pressure, and a drop of mercury. When the bulb is shaken, the neon will glow. This toy is based on exactly the same principles as our ignition system.

When these tubes are in operation, the interference patterns of the capillary waves can be seen on the surface of the mercury.

The ignition control of this timer consists of a rotating cam operating various contacts for charging and discharging a capacitor. The capacitor is discharged through the primary of a special transformer similar to a spark coil. The output of this transformer is a unilateral high-voltage pulse of a duration of a few microseconds. These pulses (See Fig. 4) are fed to the igniter well of the mercury pool tube. By timing these pulses so that they occur at any particular place of each half-cycle, we obtain a simple and reliable heat control.

The purpose of the other parts of the mechanism is only to cut out wave trains of a length of anywhere from half a cycle to six full cycles.

Bridge Circuits

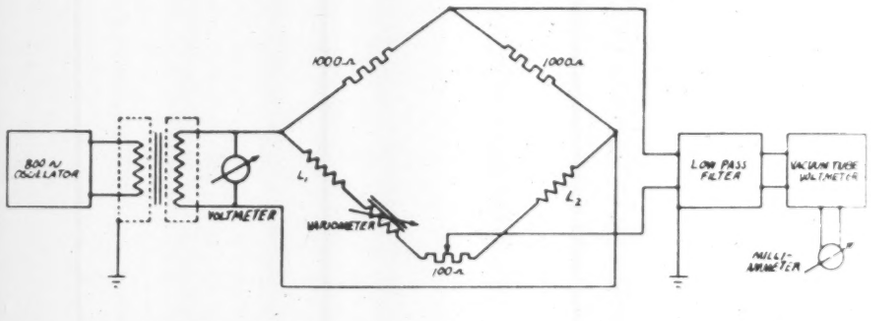
The next slide (Fig. 5) shows a rather conventional inductance bridge. This piece of apparatus can be adapted to the inspection of metals and metal parts. At first, two identical samples are inserted in the two coils and the bridge is balanced by the variometer and variable resistance. Then, one of the standards is removed and replaced by the article to be tested.

If the material is magnetic, the insertion of the part into the coils will increase the inductance. If the material is a conductor, but non-magnetic, the insertion of the pieces will cause eddy currents which appear as a decrease in the inductance. Whenever the two pieces are not identical, the bridge will be unbalanced and the vacuum tube voltmeter, with which we measure the bridge output, will show it.

The sensitivity of this instrument can be made almost anything you desire. There is nothing new about the principle. It has been used for some years—for instance, for the inspection of railroad rails in place. What we have done is only to adapt this apparatus to the inspection of very small parts. This was done mainly by increasing the frequency above 60 cycles. We are now using 800 cycles for drill rod from 1/16" up (Fig. 5), and in another model (Fig. 6) we are using 8000 cycles for the inspection of minute pinions.

An inductance bridge will, of course, show changes in dimension, changes in chemical composition, in heat treating; it will even show up strains. If a steel bar is placed in the coils and the bridge balanced, there will be an unbalance of substantial magnitude if the bar is even slightly bent.

There is nothing abstruse about this device. To make it adaptable to practical use requires, however, a considerable study of the effect of coil diameters, coil length, wire size, number of turns, and other factors. We have two of these devices on the floor, and will be glad to show you their working during the question period.



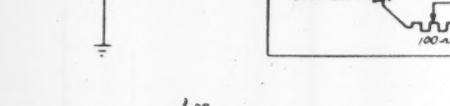
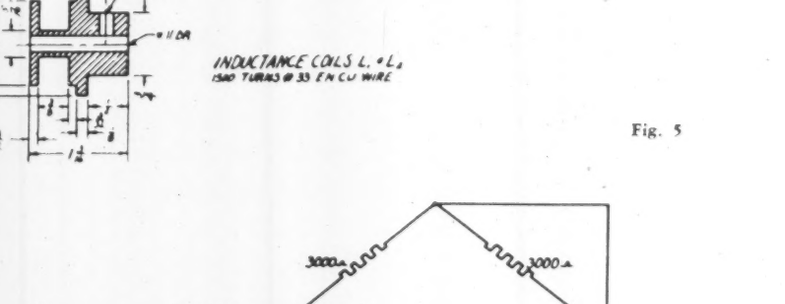


Fig. 5



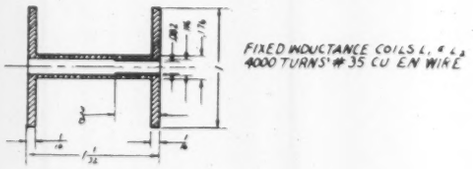


Fig. 6

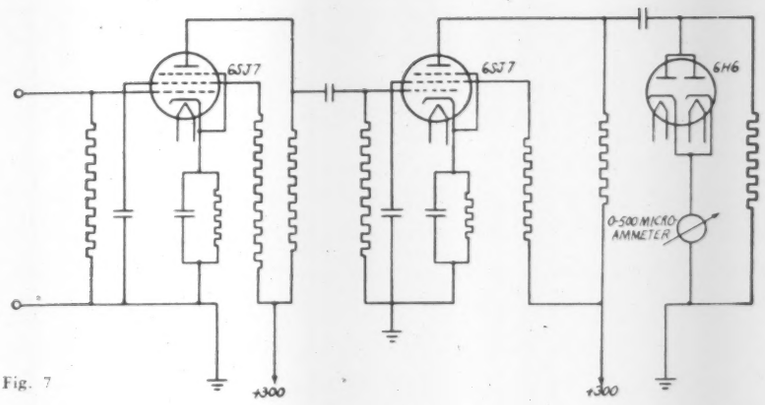


Fig. 7

The sensitivity of these bridges is quite spectacular and, offhand, one would be inclined to be quite enthusiastic about their operation. Their practical application, however, is quite another matter. Strangely, the proper use of such a device is tied up with many things outside of electronics, particularly with inspection philosophy.

You have all read about the congressional investigation of the testing methods of steel mills. You have heard much about the palming off of steel which did not come up to specifications. The bare facts and figures read quite commonplace and straightforward in the newspapers. The background, however, is far from simple.

If you were to use this bridge device as an inspection device it would function excellently if the average steel you received were quite uniform, so that the bridge would permit you to discard any steel bars which deviate from the standard by a pre-determined amount. In peace-time, such a situation might occur in some particular place. In wartime, such blessings are non-existent. With the enormous increase in production and the filtering in of unskilled help into all processes, uniformity cannot be expected, at least in metals. Consequently, at present we have no standards that are uniform enough.

As you know, the bridge reacts to variations in almost any of the characteristics of steel. Variations in size can be eliminated as a factor because steel products are delivered by the mill very close to specified size. In a few cases, you have constancy in chemical composition, but this is quite exceptional. Differences of 0.01% carbon are quite common and permissible for ordinary applications. To this, you have to add differences in the contents of manganese, silicon and sometimes small amounts of chrome or nickel which, as a rule, get into ordinary steel by accident.

All these factors create non-uniformity. In addition to all these, you have the slag inclusions which affect the bridge exactly like holes or pores, or like a reduction in size. While the chemical composition is substantially uniform, at least for a full heat of steel, the slag inclusions are distributed at random—sometimes uniformly, more often not.

In addition to that, we have another factor to consider. In the making of extremely small precision instrument parts, a reasonable amount of inclusions or pores can be tolerated, if they are of small size—let us say, less than 0.001"—in their *maximum* dimension. If these pores or inclusions are, however, of a maximum dimension of 0.002" or 0.003", they might interfere quite seriously with the smoothness of the tooth surfaces of some minute pinion or pivot.

The inductance bridge is an example of a perfectly good and intelligent instrument which will result in a total mess if it is used improperly as an inspection tool.

A similar device, with iron core coils, can be used very nicely for thickness inspection—of strips of phosphor bronze, for instance. If the bronze is tolerably uniform, you can easily detect differences of 0.0001" in a strip about 0.010" thick. I doubt, however, whether the same device could be used on beryllium copper, which has a reputation of not being uniform.

The next slide (Fig. 7) shows the vacuum tube voltmeter for measuring the unbalance of the bridge, and the next (Fig. 8) the oscillator which provides the power. Both are straightforward, quite conventional circuits on which very little development work had to be done.

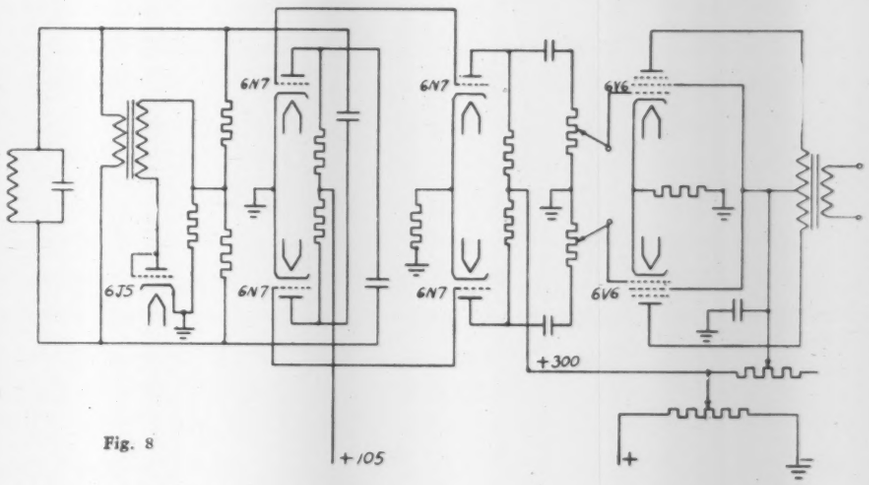
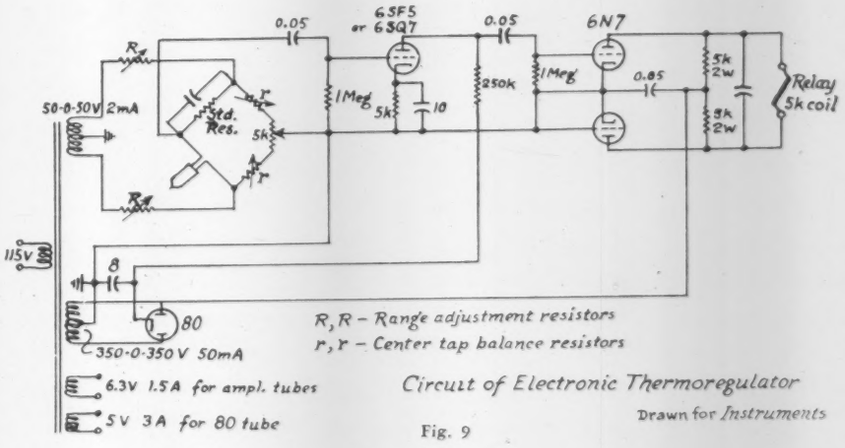


Fig. 8

Temperature Regulator

A rather novel application of an electronic circuit to measurement and control is the electronic temperature regulator shown in this slide (Fig. 9). At the left you have a conventional a-c. bridge formed by various resistors; and a small thermometer bulb which consists merely of two small electrodes immersed in a suitable organic material.

This bridge has some quite remark-



Circuit of Electronic Thermoregulator

Drawn for *Instruments*

Fig. 9

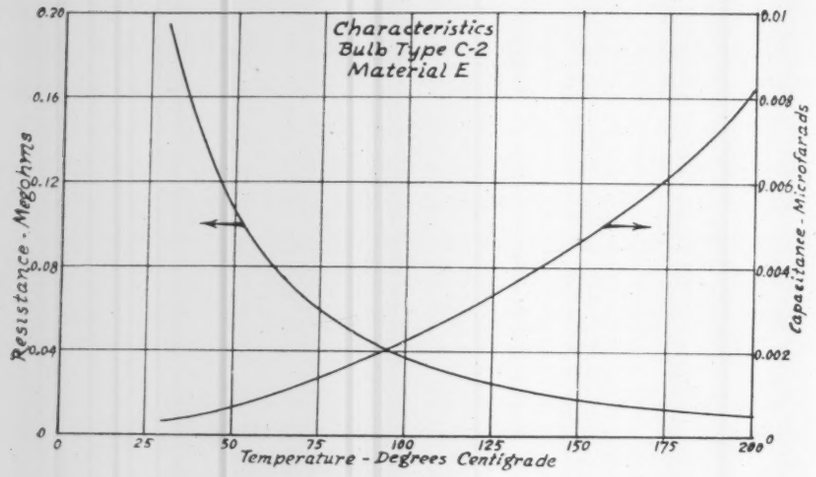


Fig. 10

able properties. In the first place, it is very stable because it is substantially self-compensating for drift in tube characteristics. It is actually a double bridge, the second half being formed by two identical vacuum tubes. The milliammeter connecting the two plates can easily be set to zero by varying one of the resistances. The full deflection can be corrected by placing a known voltage on the grid of the left-hand tube and shunting the milliammeter until the pointer coincides with the end of the scale. In this way, it is possible to correct for any variations between vacuum tubes. The effects of drift are negligible because, of course, both tubes drift in the same direction.

> "The first thing to consider in comparing an electronic device with a purely mechanical device performing the same service is to decide whether the performance is sufficiently better to warrant the higher cost."

The plates of the tubes are fed with raw a.c. This feature supplies us with the necessary phase discrimination. If the tubes are so balanced that the pointer is in the center of the scale with zero signal, the pointer will move in one direction if the bridge is unbalanced one way, and in the other direction if the bridge is unbalanced the other way. In addition, with proper selection of the circuit constants, this bridge will give a perfect straight-line output for a considerable range—something rare in vacuum-tube voltmeters.

The next slide (Fig. 10) shows characteristic resistance-temperature curves of an organic liquid. You will see that the temperature coefficient is exceptionally high—in some places about 1.5% per degree Fahrenheit. Because the resistance of the liquid is extremely high; we can use about twenty volts on the small bulb instead of the fraction of a volt which is usual on the metallic resistance thermometer.

We have available, therefore, *a thousand times* the sensitivity of a platinum resistance thermometer and can throw away a great deal of this sensitivity for the purpose of giving the instrument almost any desired characteristics.

The resistance in these bulbs is partly the resistance of the liquid intervening between the two electrodes; partly it is due to a polarization effect at the interface between the electrodes and the liquid. The basic relations of this phenomenon are still quite obscure and so far have resisted all our efforts toward a complete solution of the riddle.

You see here exhibited one temperature regulator where a relay is placed in series with an indicator-recorder connected to a motor-driven pointer by a follow-up system. Both use the same bulbs as a temperature-sensitive element.

Magnetic Field Plotter

The following slide (Fig. 11) shows the circuit belonging to the machine which automatically plots magnetic fields. This device was constructed in the course of some of our development work where it became necessary to determine accurately tri-dimensional field patterns. It can be used quite conveniently, for instance, for comparing both field strength and field configuration of magnets, as you will see when the machine is operated.

The Electronic Engineer

In conclusion, I should like to call your attention to the important fact that when it comes to judging the utility of an electronic device, the circuit alone is almost meaningless. An excellent demonstration outfit can easily be compounded, and yet prove entirely inadequate to any practical use. The skill of the electronic engineer involves a great deal more than just a knowledge of electronics. It starts with a thorough knowledge of materials and mechanical and electrical elements and their characteristics, for no electronic circuit is of much value without these elements. It requires a knowledge of the psychology, the wants, desires and foibles of the people who have to use electronic devices; a knowledge of the processes which have to be controlled or affected by electronic devices. That is where the difficulty usually comes in—not in a lack of knowledge of electronics—and you will forgive me if I say that the number of people who today have sufficient knowledge and experience in all of these matters does not run to the hundred thousands.

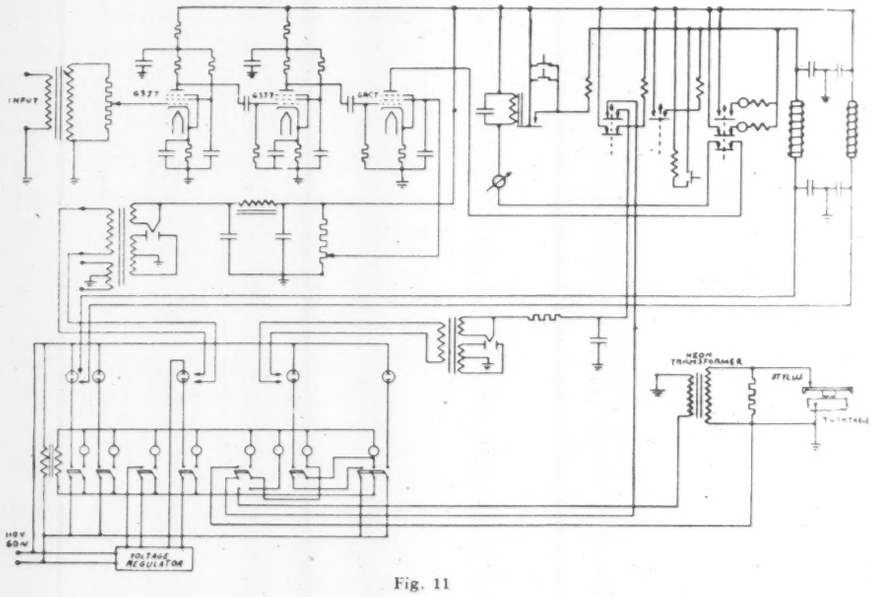


Fig. 11

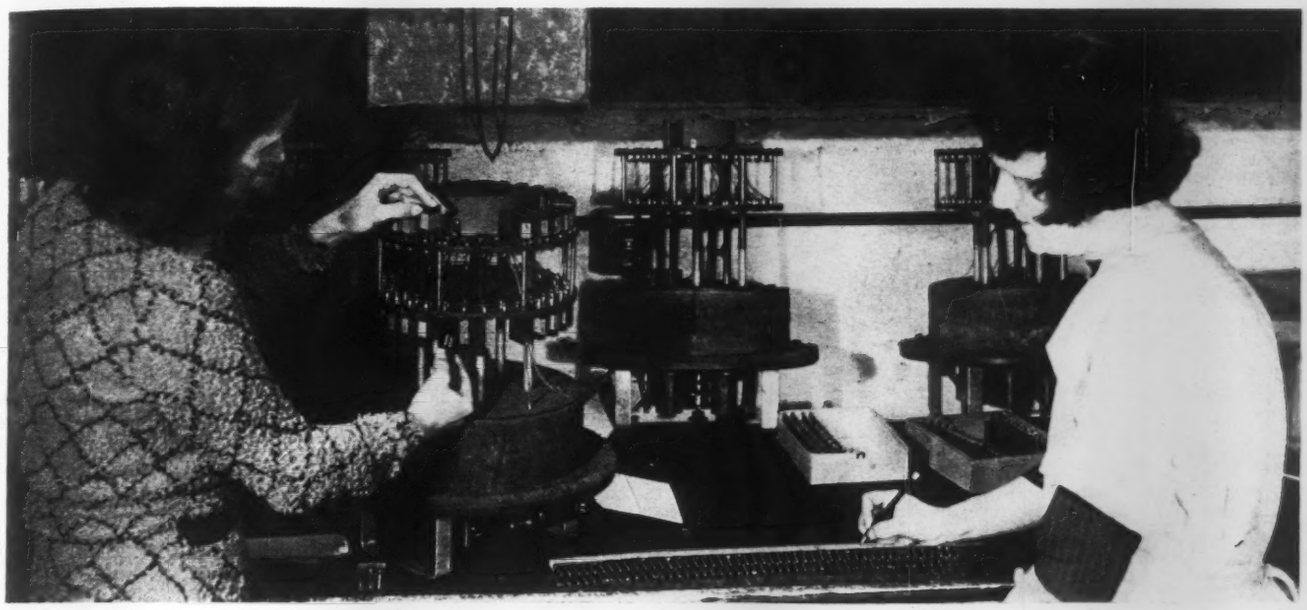


Fig. 1. Loading crystals into rotating switching unit which makes possible the automatic testing and autographic recording. *(Courtesy North American Philips Co., Inc.)*

Quartz Crystal Testing Instrumentation

By DIAMOND S. DICKEY, Murphy & Dickey, Chicago, Illinois

ALTHOUGH the scope of this discussion is limited to the subject of quartz crystal testing, the basic principles of instrument application as described herein may be employed in any number of other industries. In view of this, there is included a discussion of standard practices and basic fundamentals so that those unfamiliar with quartz crystal testing methods will have a better understanding of the problems and objectives of this particular work.

The quartz crystal, in its finished form, is a thin square wafer, sized to close tolerances, and housed in a Bakelite or non-metallic case equipped with prongs for insertion in a receptacle socket. These crystals, which may oscillate at one million or perhaps as high as nine million cycles per second depending upon their design, control the frequency at which communication sets operate. They will vibrate at a definite frequency under electrical stimulus, this vibration being determined by the crystal dimensions. There is at least one quartz crystal used in every military communication set, from the most elaborate transmitter down to the tiniest and most compact walkie-talkie. In some of the more complicated arrangements, as many as 200 crystals are used in a single set.

In order that a radio receiver may receive a message from a particular transmitter, both must operate at the same frequency. Any deviation in that frequency will cause communication failures and if the transmission wavelength shifts, one group of transmitters will interfere with another group. In a military operation, the transmitters used in tanks, in planes, by artillery spotters, and front-line observers, all operate at different frequencies so that their messages will be picked up only by the proper parties. The quartz crystals which maintain the frequency of military communication sets must, therefore, perform accurately at all times and under the varying temperatures encountered in all climatic conditions throughout the world.

As to the reason for the large number of crystals to each set, the frequencies are changed at regular intervals on a schedule determined by the Intelligence Department so as to make it more difficult for communications to be picked up by the enemy.

Each crystal, therefore, is designed to meet certain specified activity and frequency requirements. The activity of a crystal, or its amplitude of oscillation, is a function of the particular way in which it is cut from the mother crystal, its natural impurities, its dimensions as to length and width, its flatness, and the uniformity of its edges. Although the frequency at which a crystal oscillates is a function of its thickness, several other factors must be taken into consideration when designing a crystal to maintain its assigned frequency over a given temperature range change. One of these factors is the angle of cut.

In order to define the angle of cut, we must understand the first few steps in the production of commercial quartz crystals. The raw, or natural crystal is cut into thin sheets by means of a diamond-tooth circular saw. These sheets, slightly thicker than the finished crystal, are then diced or cut into squares and these squares are properly sized to form the finished crystal.

Quartz, being crystaline in nature, has definite planes of division in its structure. When viewed with an appropriate x-ray instrument, these planes are easily distinguished. When the crystal is cut into sheets, these cuts may be made parallel to these division planes, or at any desired angle from them. This angle between the plane of the crystal and the cut of the sheets is known as the angle of cut. Various angles of cut, designated as "AT" cut, "BT" cut, etc., govern the characteristics of the finished crystal as regards variation in frequency with temperature changes.

If the changes in frequency of an "AT" angle cut crystal, for example, are plotted against temperature, it will be found that the frequency increases as a straight line function with respect to temperature increases. With a "BT" angle cut crystal, it is found that frequency increases to a peak with increased temperature, and then begins to drop with further increases in temperature. The plotted curve, with frequency ordinates and temperature abscissa, becomes a sort of parabola open at the bottom. A third angle of cut gives an S-shaped curve where the frequency at first decreases, then increases, and finally decreases again with continual temperature increase.

*Presented before the Production Conference of the Chicago Technical Societies Council.

From this, it will be seen that in order to produce a crystal that will have a minimum of frequency variation over a given temperature range change, it is important to secure the proper angle of cut. At this point, we come to the first application of instruments to crystal manufacturing.

If the natural crystal were perfect, it would be a simple matter to cut all crystals at a particular angle and of definite size, eliminating the necessity for additional testing. However, impurities, strains and imperfections in the mother crystal affect both the frequency and activity of the finished crystal and, therefore, the manufacturing process is more complicated, necessitating continuous instrument testing procedure.

As previously mentioned, the making of the initial cut and slice is based on a study of the crystaline structure with an x-ray instrument. Before additional slices are made, this first slice is diced, and a sample crystal is ground to size. This sample is then tested in the laboratory. The crystal, complete with its appropriate housing as previously described, is placed in a chamber precooled by dry ice to about —50°C. The chamber is equipped with a light or electric element for heating, and a thermometer for noting temperature changes.

Leads are carried from the crystal to two indicating instruments, one of which measures grid current, thereby showing activity; and the other which measures frequency. Frequency may be measured by means of a direct-reading audiofrequency meter in a deviation circuit which compares the frequency of the crystal under test to that of a known standard.

With the crystal at the low temperature of —50°C., readings of frequency and activity are tabulated. These readings are taken at every 2° rise in temperature to perhaps as high as 120°C., depending upon the specification requirements. A study of these readings indicates whether or not the sample performs within the prescribed limits. If the activity is not correct, the sample must be re-sized. If the frequency is off, the thickness of the sample must be changed. If the frequency of the crystal varies too greatly over the prescribed temperature range, the angle of cut is probably in error.

By means of the data obtained through this laboratory test, the machinery can be set for mass production of that particular type of crystal.

In the original laboratory test setups, electrical indicating instruments are used for frequency and activity measurements, and glass thermometers for temperature determinations. With the trend toward greater rigidity in specifications, increased difficulty in obtaining trained personnel, and demand for increased production, there has been a tendency to turn to recording instruments. Recorders have eliminated errors due to the human element, have permitted putting laboratory testing on an automatic basis, and have speeded up the determination of the suitability of angle of cut and crystal size. Recording instruments have made possible notable increase in production, as will be pointed out later.

Having determined and verified the proper angle of cut, the entire raw crystal is sliced into sheets and diced. Then, along an elaborate and exacting production line, these square roughly-sized crystals pass through various machines for grinding to size and absolute flatness. The final grinding and polishing is done by hand. At various points along the line, each crystal is checked for its frequency and activity without regard to temperature.

The final tests on crystals depends upon the specifications, but are basically all the same and consist of determining activity and frequency deviations with temperature change. Under certain specifications it is required that each crystal be accompanied by a record of its performance. In a plant using ordinary testing methods and making crystals under this specification, it is necessary to have an observer continually reading indicating instruments and tabulating the results on a log sheet corresponding to the particular crystal under test. Such a method, although workable, is costly in man-hours and production time.

In at least one plant, the problem of complying with the specifications is met by using temperature chambers, each capable of holding nine crystal containers. One crystal container is equipped with a thermocouple instead of the actual quartz, so that the temperature corresponding to that inside all the crysal containers is recorded on a temperature instrument. Eight individual recording instruments are connected into the grid circuits of the eight crystals. These recorders, using a strip chart traveling at the rate of 12″ per hour, give a continuous record of the crystal activity. A ninth recorder is connected into a deviation recorder circuit by means of an automatic transfer switch. This instrument makes intermittent recordings of the

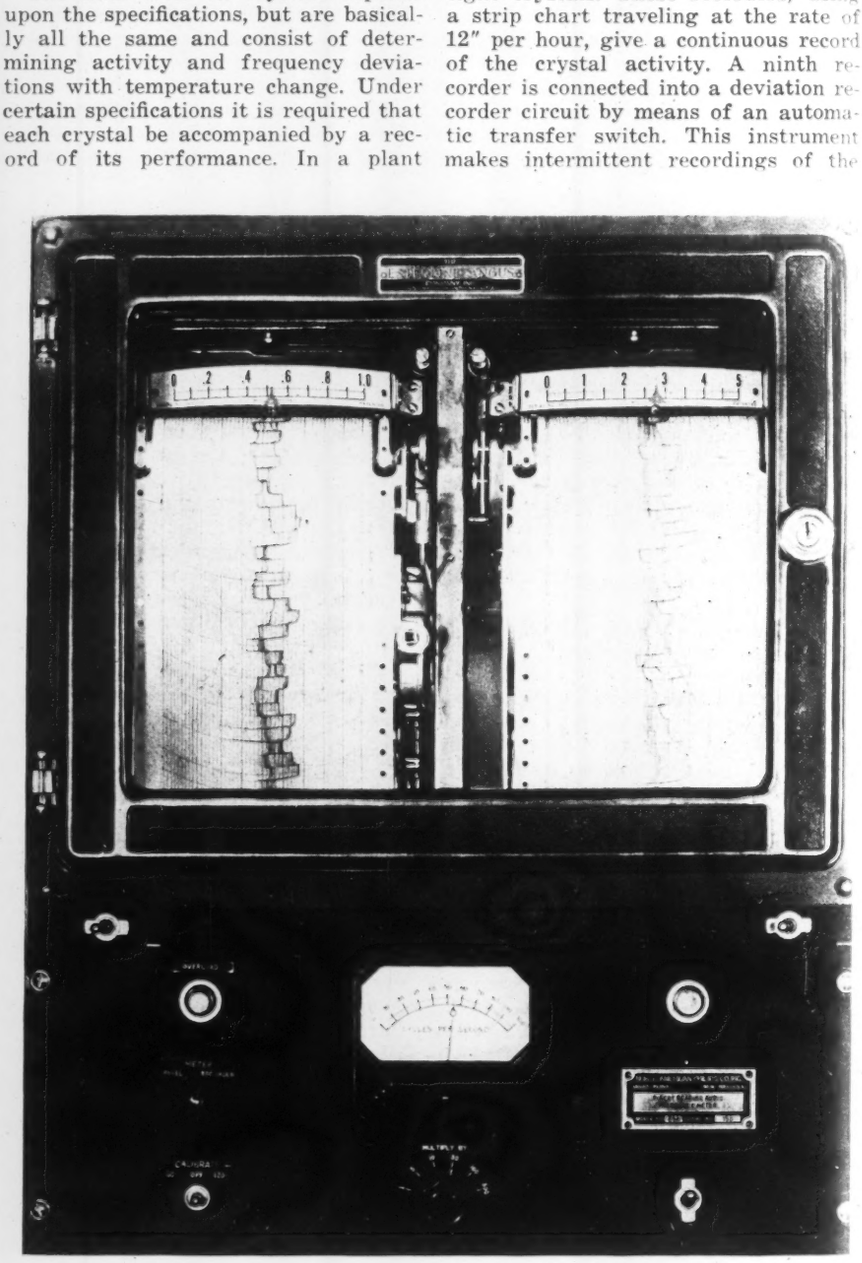


Fig. 2. Dual recorder whereby successive results of activity and frequency-deviation tests are recorded for each crystal. *(Courtesy North American Philips Co., Inc.)*

frequency of the crystal through the temperature range.

This arrangement gives the complete recorded data necessary to comply with the specifications; it eliminates all personal errors and—probably most important—frees the observer previously needed to tabulate these data to perform more important work.

Probably one of the most ingenious applications of recording instruments to quartz crystal testing is that in a plant where recorders are employed not because the specifications require them, but rather to speed up production and minimize personnel requirements.

In this plant, each test stand consists of a temperature recorder, frequency recorder, activity recorder, and a temperature chamber capable of simultaneously testing fifty crystals. The temperature recorder shows the progressive fall of temperature in the test chamber from 120°C. to —50°C. The fifty crystals are mounted on a large rotating table inside the variable-temperature box; and this table notches forward another position approximately every three seconds. The activity and frequency recorders are thus connected to one crystal for three seconds, and then switched to the next one.

The chart drives of the activity and frequency recorders are coupled together to insure exact synchronism. The chart in each recorder is of the strip type and is an 18″ endless belt that runs through the instrument over and over again.

The chart runs at a speed of 6″ per minute so it goes around the entire loop in three minutes, or 180 seconds. The sequence of events is to make a test on one crystal for a little over three seconds, and then switch to the next, then to the third, then to the fourth, and so on around the line. By the time the fiftieth crystal has been tested, the table has returned to the first crystal position, and also back again to the same point on the chart where the first crystal was tested. Thus, the second test on the first crystal is in the same location on the chart as the first test, and so the test continues. The entire test lasts for approximately an hour, this being the time required to go through the temperature range. Since one test on the complete set of crystals requires about three minutes, this means about twenty separate observations on each crystal during the hour's time.

The completed chart shows fifty consecutive groups of curves. Each group represents a separate crystal and the different curves in each group are displaced across the chart as the crystal changes its activity with temperature, or as it changes its frequency. All the test records on any given crystal should be within a certain band width on the chart and should be located within certain limits of position on the chart.

On each of the 18″ strips of chart, representing about an hour's testing, are shown twenty tests on each of fifty crystals, or 1000 tests per chart. Considering the two charts together, measuring two different characteristics, 2000 tests are made in an hour's time. All of this requires no supervision by the operator except to load the crystals into the test chamber. The only examination of the chart necessary is to see that the records are within the prescribed region of the chart, which is merely a visual inspection, and then to see that the spread between the lowest and highest result is within a certain width. This is done by checking with a divider any of the records that appear too wide.

The importance of intelligently applying instruments to the testing of quartz crystals cannot be over-stressed. As pointed out at the beginning of this article, as many as 200 crystals may be used in a single transmitter or receiver. The demand for crystals is continually growing while labor is becoming scarcer. Even if quantity requirements are not increased, the trend in increased quality and rigidity of specifications is, in itself, equivalent to a production increase.

It is not possible to give you any specific figures on the increase in production and labor savings that have been brought about through the application of instruments. However, I can say that if the tests were not made and recorded automatically, it would simply be impractical to gather the amount of data provided by the automatic method. The number of people required and the time consumed would be out of the question.

Imagine, if you will, the task of reading an instrument visually, writing down the test results and then comparing and analyzing those results with 2000 tests in one hour. Now, multiply this one installation by the twenty such installations that are in one eastern plant and you will have some idea of why I say it is impractical to gather the necessary data by manual observation.

Quartz crystal testing is just one of the many fields in which instruments are helping to relieve the critical labor shortage.

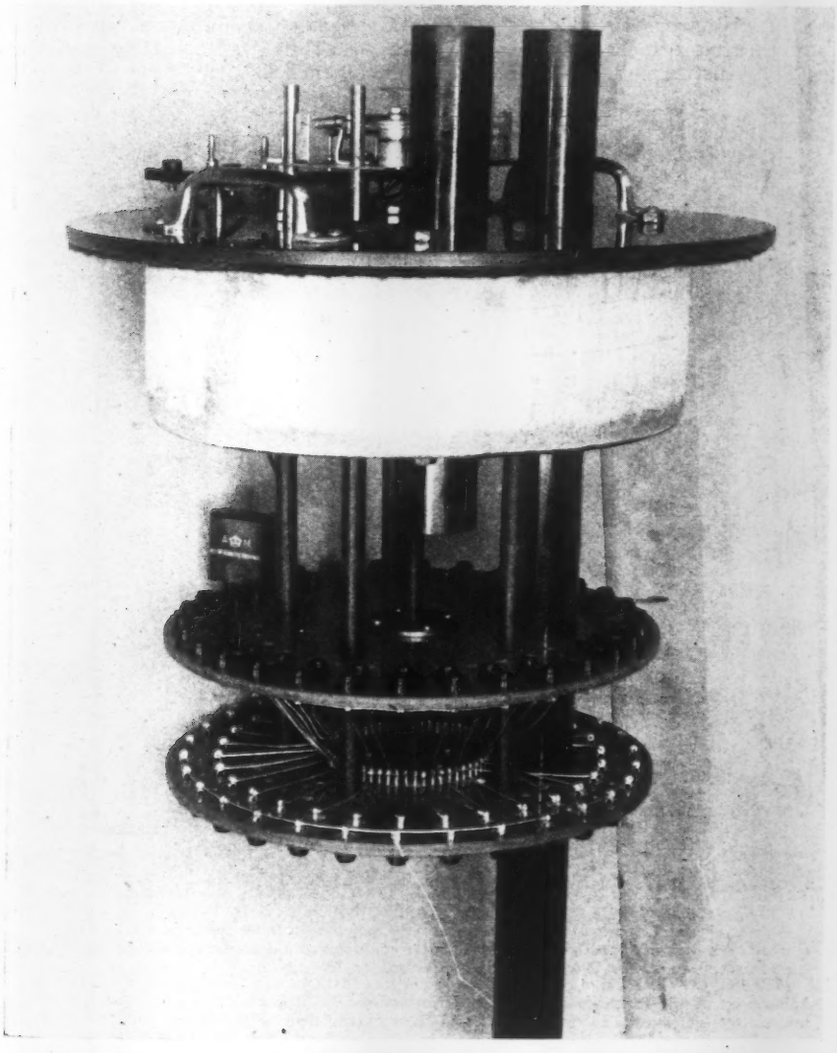


Fig. 3. Close-up of switching unit into which crystals are loaded. One "position" is not used for a crystal but for a thermocouple. *(Courtesy North American Philips Co., Inc.)*

Creep-testing Equipment at Rustless Iron and Steel Corporation

By E. E. DENHARD, Jr., Creep Laboratory, Rustless Research Division, Baltimore, Md.

IN recent years the need for alloy steels capable of withstanding the effects of elevated temperatures and high stresses in service has rapidly increased. This trend seems destined to continue in the future by reason of rapid development in the fields of gas turbines, jet propulsion engines and turbosuperchargers; and the desire and need of engineers to be able to increase temperatures of operation in steam turbine plants and in chemical purposes. As one of the leading producers of highly alloyed stainless steels, the Rustless Iron and Steel Corporation produces many of the standard types of stainless which have been and can be used in these applications. Owing to the rapidly developing demand for special steels to withstand still higher temperatures and stresses, Rustless Iron and Steel has installed equipment and has inaugurated a program of research designed to develop new and better alloys for this type of application.

In order to be able to design for an application in this field, engineers using modern alloy steels for high-temperature applications, frequently need to know the stress required to produce a creep rate of 1% in 10,000 hours and in many cases 1% in 100,000 hours. When it is realized that a 3°F. variation in temperature during creep test periods can effect as much deformation as eight days' continuous creep of this order, the need for precision temperature-control equipment at once becomes apparent.

The creep units of the Rustless Iron and Steel Corporation Research Laboratories [cover photo] employ a simple but sensitive means of maintaining strict uniformity with a minimum temperature variation.

Incoming power is ushered through two Sola constant-voltage regulators and into the primary of each of the Variac transformers supplying the creep furnaces. The transformers are so tapped that the low side is 75% of the maximum output voltage; and it is between this value and 100% that the Tagliabue Celectray throttling controllers alternately feed the furnaces in response to a thermocouple located within the specimen. The current flowing to each furnace is shown on the ammeters located on the instrument panel.

All temperatures are read off of the instrument panel through a series of jacks and selector switches. The circuits are so wired as to permit the reading of five temperatures on each of the six Chromel wound and two platinum wound furnaces. Provision is also made to record all but the control couples on one of the two Brown 8-point recorders, as well as, to check any couple at any time with an L&N portable precision potentiometer. A cold junction box maintained at 95°F. ±0.3°F. using a thermostatically-controlled and circulated oil bath, eliminates reference-junction errors. Batteries used for the Tagliabue instruments are of the Willard low-discharge type and are encased in an insulated box. The room temperature is likewise held constant at 90°F. ±1.5°F. by means of a thermostat in conjunction with air cooling and electric heating equipment.

Temperature gradients throughout the furnaces do not exceed ±2°F. up to and including 1500°F. and daily fluctuations are not in excess of ±1°F.

The measurement of elongation is accomplished by the use of a Gaertner Scientific Co. filar microscope which reads the distance between crosses on a platinum strip attached to the specimen. This instrument is capable of reading to five one-hundred-thousandths of an inch.

With the above refinements, readings in the order of 1% in 10,000 hours are accurately obtained, and figures representing a creep rate of 0.1% in 100,000 hours are reliable.

The multiple stress rupture machine, built at Rustless, pictured in Fig. 2, is capable of testing twelve specimens simultaneously, and employs practically the same control circuit as the creep units. A single Brown on-off recording controller switches from the high to low side of the tapped transformers for the simultaneous heating zones, each of which has its separate transformer. Each of the twelve specimens has three couples, any one of which can be checked with an L&N portable precision potentiometer or allowed to record on a Brown Electronik 12-point strip-chart instrument. The time to rupture of each specimen is registered on Weston Elapsed Time indicators operated by Micro Switches.

Fig. 2. Special furnace for testing alloys to the point of rupture under stress at elevated temperatures was designed and built by Rustless engineers to aid in the development of new high-temperature steels. Ductility also is measured in this unit.

{FRONT COVER} Fig. 1. Battery of eight creep strength furnaces installed in the Research Laboratory of the Rustless Iron and Steel Corporation is used to test the stretch of alloys under stress at elevated temperatures. These furnaces and their recording and control equipment are aiding in the development of new high-temperature alloys for gas turbines and for other uses where great strength is needed at elevated temperatures. Resistance to scaling also is tested with this equipment at Rustless. Mr. Denhard is pictured.

Veterans Will Make Good Workers, IF . . .

By Sergeant ERNEST W. FAIR, in France*

"VETERANS will make good workers in the field of instrument repair and instrument manufacture . . . their experiences in the service have been such as to fit them readily to these civilian jobs."

Doesn't sound quite right, does it? The truth is that the statement quoted cannot stand up when applied to any and all veterans; but it is true when applied to certain groups and classes of ex-servicemen. *These* men have received specific and specialized training that will fit them to these jobs like kid gloves fit one's hands.

Never before in the history of warfare has the average soldier been given as much and as thorough training as he received in this war. The army had no other choice: it had to train thousands and thousands of specialists and it had to train every last man in certain fundamental mechanical principles . . . else we would have lost this war!

There have, of course, been many cases of stupidity in the army's training program, but for every soldier who was inadequately trained to do his job there were a thousand trained to do it right.

All of this training can be utilized by every employer within the vast instrument-using and instrument-making industries from the smallest to the largest institution.

The writer, by the fortunate nature of the army jobs assigned him, both in the U.S.A. and abroad in combat, has had ample opportunity to see the results of this training in action and to know that it has not been wasted —that today's veterans are better trained to hold their jobs in the instrument field than ever before.

Naturally, not every veteran is so readily adjustable to a job in industry. The key to the selection of just the right man is there, however. In the paragraphs to follow are summarized just who these men are, what they did in the army and what training they received.

By their MOS's you shall know them!

For the uninitiated, an MOS is a soldier's Military Occupational Specialty or, in plain words, the job he did while in the service.

In general, the men who did such specific work in the greatest army of specialists ever known, can be readily adapted to its counterpart in civilian life. There are a number of specific army specialty numbers covering the instrument field. Most of these men have been so thoroughly trained in army schools and by their on-the-job work that they can readily step from uniform into their civilian clothes and be on the job in short order. In this field the work so closely parallels that little more needs to be learned by the veteran other than those changes he must make from the army way of doing things to the civilian way.

Here are the "instrument" MOS's:

Airplane Instrument Mechanic (957) — Inspected, disassembled, repaired, cleaned, assembled and calibrated electrical, mechanical or gyro-operated aircraft instruments such as pressure gages, altimeters, bank and turn indicators, rate-of-climb indicators, compasses and temperature indicators. Used such tools and equipment as ammeter, voltmeter, ohmmeter, electrical and hydraulic test stands, electrician's hand tools and instrument repairman's tools. Completed a course in aircraft instrument repair at an army school.

Airplane Instrument Specialist (686) —In connection with periodic aircraft inspections, visually examined, checked operation and analyzed malfunctioning of pressure, electrical and gyro-operated aircraft instruments. Completed a course in aircraft instrument maintenance at an army school.

Instrument Repairman, Height Finder (921)—Maintained and made major repairs on all height finders and fire control instruments such as range finders, aiming circles, telescopes and non-optical instruments; operated precision bench lathes, drill presses and grinders; used instrument maker's tools including collimators and vernier gages; had to be able to work to minute tolerances. Generally has completed a course in the repair of height finders and fire control instruments at an army school.

Electrical Instrument Repairman (338)—Cleaned, adjusted, repaired and calibrated such electrical instruments as voltmeters, recording gages, relays, motor starting boxes, ohmmeters and other electrical instruments. Machined and fabricated parts, using precision lathes and grinders. Used instrument maker's and electrician's tools. Completed a course in repair of electrical instruments at an Ordnance school.

Non-electrical Instrument Repairman (098)—Maintained and made major repairs on sensitive non-electrical instruments and apparatus used for measuring, testing, recording and other related scientific operations and observations. Has a working knowledge of mechanics and physics. Completed a course in repair of non-electrical instruments at an army school.

Survey and Instrument Man (228)—Set up and operated surveying and fire control instruments to locate gun positions, observation posts or to conduct survey operations. Used most such instruments, maintained and repaired them.

Administrative NCO (502)—Supervised and directed work of one or more administrative sections of a headquarters organization in the preparation of correspondence, records, forms, reports, etc., supervising preparation of such items and generally has a wide range of office experience.

Electric Motor Repairman (304) — Installed, tested and repaired electric motors and accessory equipment and has familiarity with motor operation, electrical theory, and the use of most hand tools. In some instances received a course in electrical repair work in an army school.

Auditor (390) — Audited fiscal or property records, examined inventories and property vouchers, etc., and generally had a college degree with major specialization in accounting or business administration or a great deal of civilian experience before coming into the army.

Cashier (269)—Received, issued receipts for, recorded payment of accounts and cash sales at army installations, operated office equipment, some bookkeeping work, and had to know a wide range of prices and be adept at figures.

Shop Clerk (457) — Performed various clerical and technical duties in connection with the operations of military shops, etc., kept records and generally had similiar civilian experience before entering the service.

Stenographer (213) — Took dictation in shorthand of correspondence board proceedings, hearings, reports, etc.; generally an accomplished typist, did filing, indexing and record-keeping and operated various office machines.

Supply Clerk (835) — Performed various clerical and stock-handling duties in connection with receipt, storage, issue and shipping of general supplies and equipment. Maintained stock records pertaining to such items as amount, kind, and value of supplies and equipment received, issued, expended and balance on hand. Sometimes has completed a course in supply activity at an army school.

Clerk-Typist (405) — Performed numerous clerical and typing duties in headquarters units, used most office machines and equipment.

The training of such specialists has enabled them to be of considerable use and readily adaptable to many jobs in the instrument field. A familiarity with army MOS's and what they mean will aid every employer in speedily and profitably adapting the veteran to his job wherever he may be hired.

It makes much easier that all-important practice of "picking the right man for the right job."

*In France at the time of writing; probably back home in Oklahoma when this is printed in *Instruments*.

Scientific Glass Blowing and Laboratory Techniques

By WILLIAM E. BARR and VICTOR J. ANHORN, Gulf Research & Development Company

II. ELEMENTARY GLASS BLOWING SEALS

The fabrication of durable and perfect glass apparatus can only be assured by a complete mastery of fundamental operations. Certain techniques in handling glass are involved and if extreme care and patience are exercised in learning the basic procedures of sealing glass, no difficulty will be encountered in fabricating more complex equipment.

The beginner may find that the first problem in glass fabrication is the proper degree of fusion of the glass. Glass is essentially a super-cooled liquid and consequently does not have a definite melting point but will soften gradually and finally flow when heated in a blast burner flame. The temperature range of fusion depends on the type of glass but in general the degree of fusion required for successful fabrication of nearly all glasses is approximately the same. Glass must be fused sufficiently for correct handling. This in itself is sometimes quite a problem, for the beginner frequently does not heat the glass sufficiently for good leak-proof seals. The other extreme is that the glass is fused so much that the potential glass blower loses control over his work and his glass seals are of varying wall thickness.

The correct procedure in learning to fuse glass is to make certain that the glass is heated uniformly in the burner flame. In making seals with tubing or heating glass rods, it is necessary to rotate the glass in the hottest zone, which is at the tip of the blast burner flame. It is desirable that a minimum of glass be heated and fused in completing seals because no matter how careful a glass blower may be, it is extremely hard to make perfect seals with wall thickness identical to that of the original glass. If a large portion of the glass is deformed by partial fusion it will require more work in making smooth seals.

Three characteristics of fused glass influence successful manipulation. They are as follows:

1. Gravity.—Glass in a viscous state will always flow with gravity. To properly seal glass it must be continually rotated as it is being fused or it will sag and become so deformed that smooth glass seals are impossible.

2. Surface Tension.—Viscous glass has also a tendency to flow under the forces of surface tension. Fusion will yield rounded ends on rods, and tubes are fire-polished by heating them sufficiently to fuse the edges. Surface tension of the fused glass will cause it to flow to give rounded ends or edges. There are, however, instances when surface tension forces are not helpful in working glass. This occurs when small sections of glass are not entirely joined in making glass seals. Fusion of these small openings will cause an enlargement of round holes; and then such holes can be closed only by pulling the fused glass together with a small glass rod. Another procedure is to deform the seal sufficiently to close the opening before work is continued in completing the seal. The latter procedure is not recommended since additional work is required in shaping the glass to form a good seal.

3. Timing in Working Glass.—Seals are made by working together the glass of two tube sections. This is accomplished by the process of collapsing the glass at the seal with heat and then expanding it with air pressure by blowing into the assembly. It is important that blowing out the glass is timed in such a way that when the desired wall thickness is obtained, pressure is momentarily released to allow that glass to cool just enough so that it cannot be expanded upon further blowing. Should portions of this seal still have heavy walls, they can then be blown out because the temperatures in these parts are still high enough to permit the glass to be expanded under pressure. The glass can thus be worked to a uniform wall thickness by repeated collapsing, expanding and pulling the expanded portion to the diameter of the tubing.

Choice of Glass for Instruction and Practice.

The choice of glass will depend on the facilities available. Lime or soft glass can be worked with gas and air. Economy is effected in using this type of glass because no

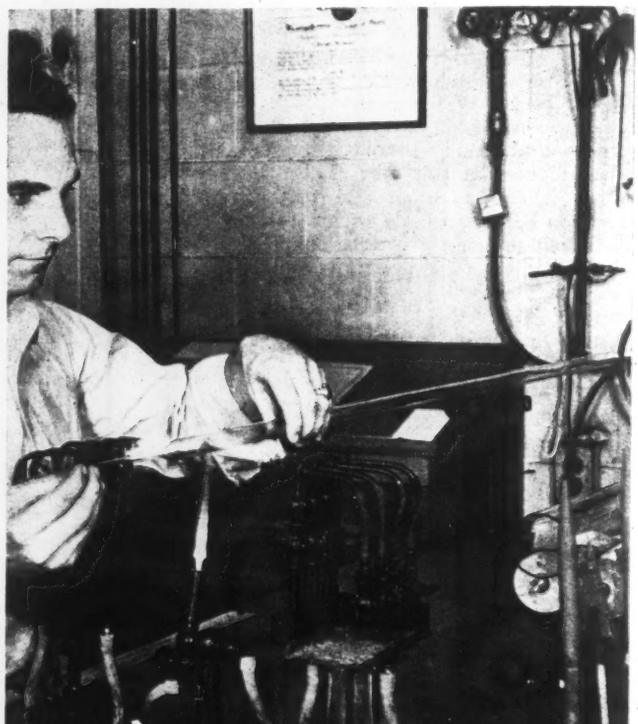


Fig. 25

oxygen is required as in the case of working Pyrex. The former type of glass is also less expensive. There is, however, little difference in the technique required for working either type of glass. As lime-soda glass has a higher coefficient of expansion; it must be heated more slowly; and if it is used in capillary tube form it must be carefully annealed. Pyrex glass has a rather low coefficient of expansion and can be heated more rapidly.

Annealing

The annealing of glass seals is important if durable equipment is desired. Internal strains are always developed when glass is fused and sealed and, to relieve the majority of these strains, glass must be heated to annealing temperatures. This may be accomplished by heating the glass in electrical furnaces or with annealing burners. The former method will be described under the fabrication of more complex equipment. The latter method is best performed by heating the seal in a large gas and air flame of an annealing burner. The glass is heated until it has a dark cherry red color. Under these conditions it becomes pliable and care must be taken in the rotating movement that the glass is not forced in any way. The air is turned off and

the glass is coated uniformly with a thick layer of carbon.* It is then removed from the flame and allowed to cool without touching cold surfaces.

All seals should be annealed as soon as they are finished. This is especially important in more complex work because the seals when completed are hot and there is less danger of cracking the glass by the necessary reheating. If it is necessary to anneal the glass at a later time, it must be heated slowly to the annealing temperature by gradually

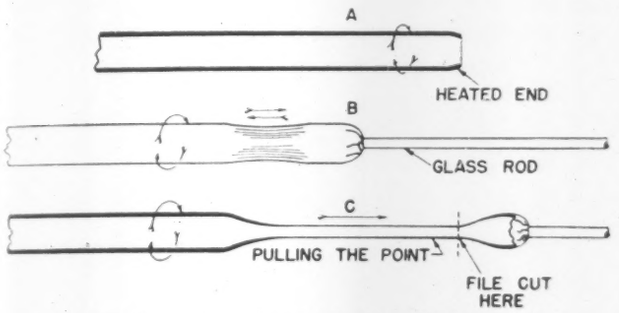


Fig. 26. *(Drawings by Richard P. Jones, Engineering Dept., Gulf Research & Development Corp.)*

increasing the gas and air to the burner. Frequently a straight gas flame is desirable during the warming period before air is added to attain the annealing temperature.

Point Pulling

Fundamentally the basic technique in the art of fabricating glass is the proper handling of the glass while it is being fused. Small tubing can easily be handled but to relieve awkwardness in working larger tube sizes, a portion of the glass is most conveniently drawn down to a long heavy-walled point. This forms an axis, about six inches in length, with which to hold and rotate the glass. In addition to being heavy enough to bear the weight of the tube, it has also to be truly coaxial with the tube to permit rotation without wobble.

The size of the point is determined by the amount of glass used. Although there is a definite increase in wall thickness with an increase in tubing diameter, the amount of glass needed for good heavy points on larger tubes must be obtained by heating a longer section of the glass.

Pulling points on glass tubing is given in three steps. The proper hand hold for point fabrication is shown in Fig. 25. The left hand, arched at the wrist, supports the main weight of the glass; the right hand supports the end of the tube. It is more economical to use glass rods about four inches long, especially when large tubes are being worked, because it is easier to follow the rotation of the glass by turning the glass rod with the right hand. Practice in holding and rotating the glass as outlined above is required before an attempt is made in point pulling.

The tube must be perfectly balanced while it is being rotated and, when points are to be pulled on large sections or large-diameter tubing, it is better to use aligned double rollers for a support: the glass tube is pressed against the rollers and rotated with the palm of the left hand.

1. After the hand hold and the rotation of the glass has been mastered the end of the tube is fused as shown in Fig. 26A. A glass rod is then attached to the fused end and centered with the right hand while the tube is being rotated. The rod must be truly centered because the point axis will depend entirely upon the alignment of the attached rod.

2. The tube is heated at the shaded section as shown in Fig. 26B. Two distinct motions are required, tube rotation and a longitudinal movement. The latter is governed by the tubing size because more glass must be used for heavy-walled points on larger sized tubing. The glass is heated over the specified zone until it becomes uniformly dark cherry red.

3. It is then removed from the flame and drawn slowly down to a point. The dotted line in Fig. 26C indicates the position of the file cut to remove the waste glass.

Continued practice is recommended. This is accomplished by pulling successive points with bodies about two inches long on a long glass tube which is supported on rollers. Each point is used as a handle for the next one.

A second exercise which is useful in developing the technique of holding the glass in the left hand is to cut a glass tube about one inch in diameter into sections one foot in length. The sections are supported in the left hand as shown in Fig. 25 and successive points are pulled on the tube. In this case the body of the tube may be restricted to about one inch in length.

Cutting Glass With Blast Burner

The technique in cutting glass with a file has been described in Chapter I. In preparing tubing ends for butt seals it is advisable, however, to cut the tube with the burner flame. File marks are hard to eliminate from the glass and when seals are made with tubing containing these marks a small opaque section is always apparent in the seal. This can be eliminated to a certain extent by fusing the tube end and working the glass with a small round or hexagonal carbon tool. The best method in preparing tubing ends is described in the following operation:

1. The section of tubing with an axial point shown in Fig. 27A is held in the left hand. The end of the tubing body is fused in a blast burner flame by uniform rotation of the tube.

2. A glass rod is attached and centered to the fused end. The section illustrated by the shaded portion in Fig. 27B is then heated in the flame by continually rotating the glass by both the point which is held in the left hand and the rod which is held in the right hand.

3. After the glass has fused sufficiently, it is drawn apart by pulling away the portion fused to the glass rod. This operation is completed without removing the glass from

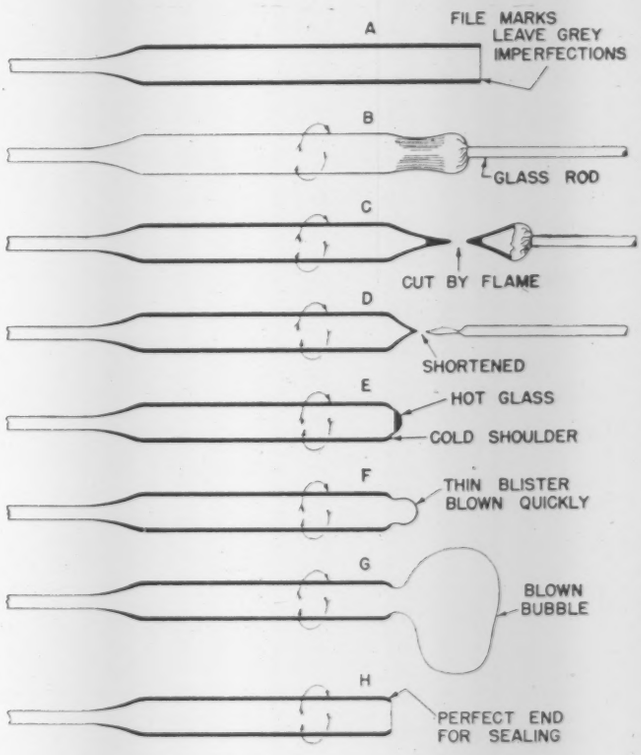


Fig. 27

*The glass is coated uniformly with a thick layer of carbon by incomplete combustion of the gas: The deposit of carbon forms on the glass when the temperature of the glass drops to that of the gas flame. This is desirable in order to keep the outer surfaces hot and still allow the overall temperature of both inner and outer sections to drop slowly.

the flame. The closed end of the tube has the shape shown in Fig. 27C.

4. The slightly elongated tip is removed by again attaching the glass rod while the tube tip is rotated in the flame. The glass is then cut away by heating between the shoulder and tip of the closed tube and pulling off the excess glass with the rod as shown in Fig. 27D.

5. The tubing end is allowed to cool slightly. The tip is heated with intense heat until the fused end appears as shown in Fig. 27E. At this time the open end of the point is brought quickly to the lips. A small puff will blow the white-hot lens-shaped portion of the glass into a small bulb as shown in Fig. 27F.

6. The tube end is allowed to cool slightly and then reheated at the bulb by even and continued rotation. When

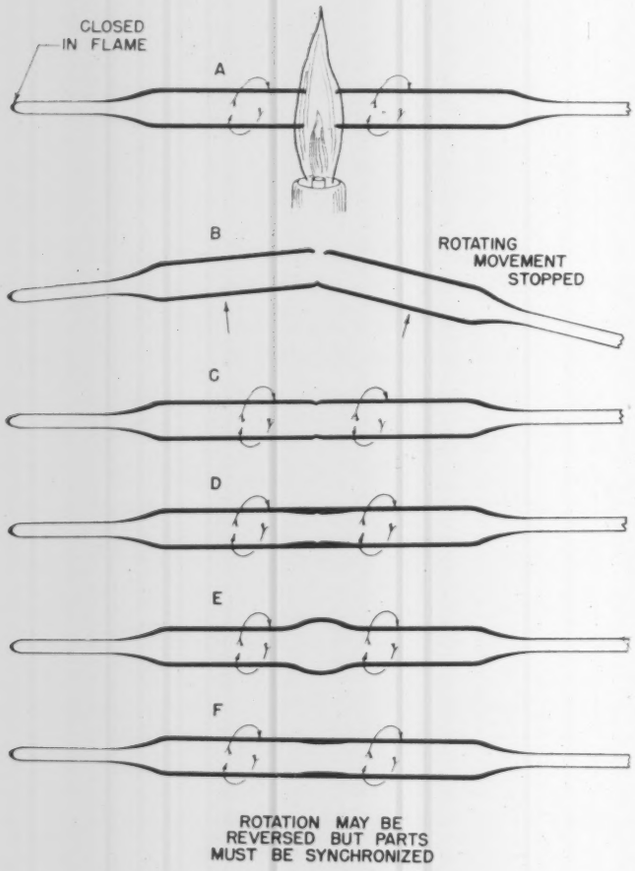


Fig. 28

the glass becomes hot the end is blown out by again blowing quickly into the open end of the point. As the bulb enlarges to a 2" diameter, air pressure is released. The form of the tubing at this stage is shown in Fig. 27G.

7. The thin bulb is then scraped away by a sidewise movement of the forceps. The rough unfinished edge is then fire polished in the flame by heating the end with even rotation until it is fused as shown in Fig. 27H.

Butt Sealing

Regardless of tubing size, the following technique is used in sealing together glass tubing with identical diameters. A point should be drawn on the two tube sections unless the diameters are below 10 mm. Two ends are prepared as described above. The ends should be even and square with the tube. The burner is then regulated to give a narrow flame and the open end of the point, to be held in the left hand, is closed by fusion in the burner flame. All blowing operations are performed through the end of the point which is balanced and held with the fingers of the right hand. The sealing procedure is as follows:

1. Both ends to be sealed are rotated in the flame to insure even fusion around the entire circumference of t tube end as shown in Fig. 28A.

2. The tubes are contacted at an angle as shown in Fi 28B so as to form a hinge to steady the hands while t tubes are brought into exact register and butted togethe

3. The joined ends are then heated around the circun ference by continued rotation. The beginner will find difficult to synchronize the rotating motion of both hand When a drag is noted, because the rotation of one tube faster than the other, the direction of rotation should l reversed before the two tubes are twisted at the fused po tion.

4. A constriction occurs as the glass is further heate This is shown in Fig. 28C.

5. After the constriction becomes quite noticeable, t glass is removed from the flame and the constriction enlarged by blowing through the open end of the poin held in the right hand. In removing the glass from th flame for blowing, the temporary shape of the joint mus not be altered by pushing, pulling or twisting. The shap of the tubing at the seal is shown in Fig. 28E.

6. The seal, which has been blown to a diameter slightl beyond that of the original tubes, is then heated in th flame until the glass fuses without collapsing. The en larged portion is then removed from the flame and draw to the diameter of the two tubes.

The principal aim in making seals is to work the glas so uniform in thickness with the walls of the tube on eithe side as to render the joint almost invisible. If the seal, when completed, has thinner walls than the rest of th tubing, it will be more easily broken.

Since glass work is largely a matter of joining glas sections, the glass worker should strive to master butt seal ing completely by continued practice. Two important re quirements in working glass must always be remembere in making butt seals. First, the glass tube section at th seal should be worked by collapsing and expanding th glass until a good seal is obtained. The fused glass is the expanded slightly greater than the tube diameter. Second ly, this expanded section is drawn down to the diameter o the glass tubing.

The natural sequence toward more complicated work in butt sealing is to join together two tubes of different diameters. A suitable selection would be to join a 6-mm. tube to a 13-mm. tube. A point will not be required on the small-diameter tube, but one should be drawn on the large size. With this combination of ends, the rotation of the glass by each hand is more nearly matched. The small tube is opened by cutting with the blast burner as previously de scribed. The larger tube is cut in a like manner but the end should be prepared so it will match the opening of the smaller tube. This is accomplished as follows:

1. The larger tube is held by the point with the left hand. The end is fused by uniform rotation and then drawn to a heavy-walled cone by attaching a glass rod to the fused glass. One should draw this cone slowly while it is rotated in the flame. After a satisfactory cone has been formed, the glass rod is removed by first allowing the cone to cool and then cutting the glass rod and excess glass be yond the apex of the cone. The finished tube is shown in Fig. 29A.

2. The apex of the cone is heated and fused in the flame until the diameter of the lens-shaped glass is that of the 6-mm. tube. The fused glass is then blown to a small bulb by quickly removing the glass from the flame and blowing into the open point end. The shape of the tube end is shown in Fig. 29B.

3. The small bulb is heated and, when the glass is fused sufficiently, it is blown out into a large thin-walled sphere In heating the small bulb the glass of the remaining cone wall should not be fused because of the danger of enlarg ing the diameter of the opening at the cone apex. The thin glass is then scraped away and the opening is fire polished

4. The two glass tubes are then sealed together as has been described under butt sealing. The small tube is left open for blowing and the point end is sealed. Care must be

taken that the thickness of the glass is evenly tapered from the small tube to the large tube and that the two are coaxial. The finished seal is shown in Fig. 29C.

This type of seal may be improved in appearance as shown in Fig. 29F. The procedure in fabricating this seal is slightly different from the cone-shaped seal.

1. The large tubing is drawn down to a thin-walled cone by fusing the glass and drawing down with an attached glass rod. The excess glass is cut away with the burner flame.

2. The cone apex is heated until the lens-shaped glass at the apex has the same diameter as the smaller tube. This glass is blown out to a small bulb and, after further heating, is blown into a sphere of thin glass. The glass of this sphere is scraped away and the tube end is fire-polished to a smooth square end.

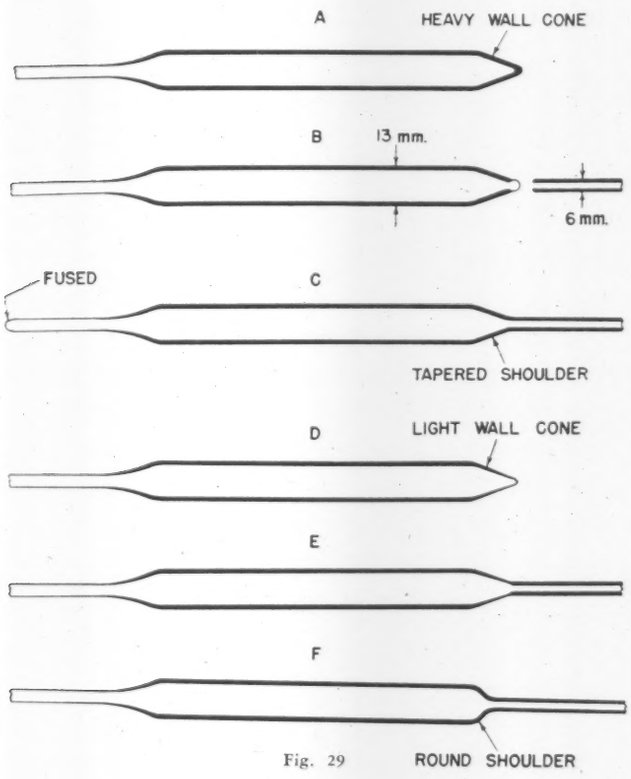


Fig. 29

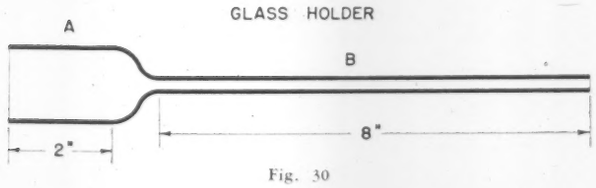


Fig. 30

3. The two tubes are sealed together as before by attaching the two fused ends and rotating in the flame as has been described under simple butt sealing.

4. The conical section is heated uniformly and blown out slowly into a hemispherical shape. The two tubes are pressed together slightly during the final blowing stage.

This technique in making reduced seals is used in preparing glass holders. The tubes are sealed as described and the large tube is cut squarely with a cutting wheel. Such a holder is shown in Fig. 30. The small tube should be about 8 mm. to 10 mm. in diameter while the larger tube should vary in size from 18 mm. to 64 mm. These holders will serve in place of points. With a glass holder of an appropriate size, various diameter tubes can be worked by the simple expedient of wrapping asbestos tape around the glass tube and inserting it into, or around, the holder. The holder, when properly fabricated, must not wobble as it is rotated and, by proper alignment, the inserted tube will be truly axial.

The asbestos tape should be heated in a gas and air flame to burn out the binder because the smoke from hot new tape will tend to spoil seals and darken glass surfaces. Two sizes should be kept on hand: the 1" and ½" wide tape. It should also be quite thin (0.015") so that it can be wrapped tightly around the glass.

Capillary Seals

There is an increased demand for instruments made of glass for measurement and control purposes, such as McLeod vacuum gages, manostats, thermoregulators and rate-of-flow indicators. These instruments are generally built with a combination of bulbs, tubes and capillaries. Since the purpose of the capillary is to decrease volume or restrict flow, it must be drawn with an abnormally heavy wall for strength. In working this heavy-wall and fine-bore tubing a slightly different technique must be used.

The first exercise in handling capillary tubing is the seal of capillary to glass tubing of the same outside diameter. The steps of the procedure are as follows:

1. The capillary tube is held in the left hand and the end is fused until the bore is closed, as shown in Fig. 31A.

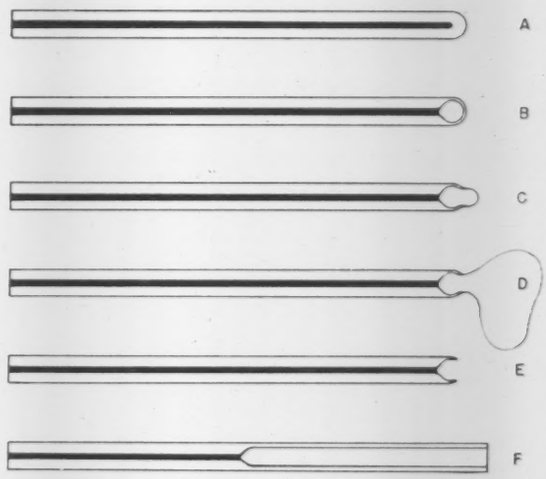


Fig. 31

2. The fused end is blown out until the diameter of the bulb is equal to that of the capillary tube as shown in Fig. 31B.

3. The bulb is allowed to cool and then it is heated with tube rotation until the glass is fused at the end. The glass is then blown out as shown in Fig. 31C.

4. The extended bulb is heated at the tip until a small lens-shaped globule of glass is formed. This is quickly blown out to a thin-walled bulb, Fig. 31D.

5. The excess glass is scraped away with a forceps and the end of the tube is fire-polished in the burner flame. The final shape of the capillary tube end is shown in Fig. 31E.

6. The end of the glass tube is prepared and the seal is completed as has been previously described; care should be exercised that the capillary tube is not heated too close to the bore.

If capillary tubing is to be sealed to bulbs or tubing with diameters greater than the capillary, the same technique is used in preparing the latter. The opening on the large tube is fabricated so the diameter of the opening corresponds to that of the capillary as shown in Fig. 31E. The heavier tube is then taken in the left hand and the seal is completed by heating the shoulder of the larger tube and working the glass by collapsing and expanding until a uniform wall thickness of the shoulder is obtained.

Capillary-Capillary Tube Seals

When two pieces of capillary are sealed together, it is preferable not to fabricate the ends as described in sealing capillary to glass tubing. Since the wall thickness requires

a very hot, small and narrow flame, it is best to use a Hoke Jewel torch. The hottest point is at the tip of the noticeable bright blue flame. The procedure in completing such a seal is given in the following steps:

1. The end of one capillary is closed with a wooden air stop, while the other tube is left open for blowing. These two tubes are heated in the flame until the glass just begins to flow. They are then joined by touching the edges together on one side as shown in Fig. 32A, and brought together so the bores are perfectly aligned.

2. The seal is worked by collapsing with heat as small an area as possible, to about half the actual bore size, and

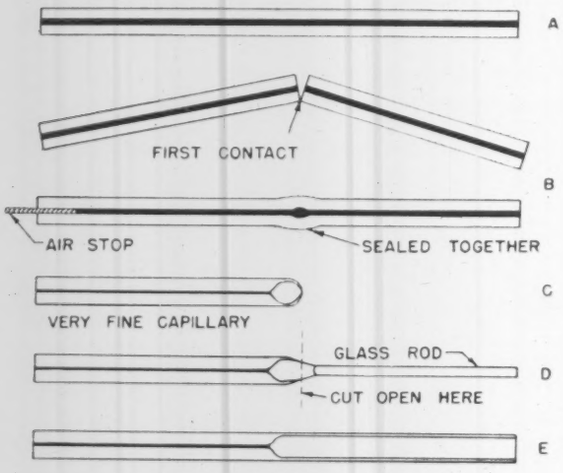


Fig. 32

expanding it with pressure to about twice the bore size. A repetition of this procedure will complete the seal as shown in Fig. 32B. Capillary seals should be carefully annealed because of their heavy walls.

Capillary-to-capillary seals are generally used in the assembly of gas-analysis equipment. A butt seal with an even- and constant-diameter bore presents a minimum of gas space which is advantageous in such systems. Generally, these systems are designed to use a standard 2-mm. bore.

It is difficult to blow through fine-bore capillary tubing. This obstacle may be overcome by the use of a reduction valve on a compressed-air line. The pressure is set at 4 lbs./in.^{2} and introduced into the capillary through a rubber tube and metal swivel joint. The procedure in sealing this small capillary-bore tubing to glass tubing is as follows:

1. The rubber tube from the air pressure line is connected to one end of the capillary. The other end is fused by rotating in the flame. After the glass end is closed by fusion, the air pressure is admitted, regulated and shut off after a bulb equivalent to the tubing diameter is blown. The form of the bulb is shown in Fig. 32C.

2. The bulb is heated and as it begins to collapse, a glass rod is attached and the bulb is drawn out as shown in Fig. 32D and cut with a file at the point designated by the dotted line.

3. The seal is then completed by heating, collapsing and expanding the glass, the latter being accomplished by blowing through the open end of the larger tube.

Angular Joints or Side Seals

For satisfactory results in making angular joints or side seals, a precise procedure is necessary if the seals are to have a professional appearance. A method frequently used in making a side seal is to join a tube to a perpendicular tube by butting the open end of the first to a hole on the side of other. This seal is made as the operator fuses and expands small segments of the circular seal, step by step. This method is unsatisfactory because it takes considerable time. The time element is a critical factor when side arms are being sealed on a complicated section involving closed systems and multiple ring seals. The same temperature must be maintained over-all on intricate sections. Time lost on the slow placement of side arms, with consequent spotty heating, would be costly because of the danger of undue strains in the glass. Therefore, side arms should be placed quickly with a circular movement of about a 200 to 360° swing in a plane perpendicular to the side arm. This is a skilled operation, for the art of swinging the glass through an arc of 360° in making side seals requires a good deal of practice. In addition to rotating the tubes, the glass must be fused and worked correctly to yield a seal with uniform wall thickness. To emphasize the correct procedure in working the glass at the seal the following exercise is recommended:

1. The end of a 6" section of glass rod is fused and attached to a glass tube about five inches long as shown in Fig. 33A. One end of the tube is closed with a cork.

2. The tube is heated exactly opposite the attached rod. The fused glass is drawn out with another glass rod, Fig. 33B, which is held in the right hand. This rod is cut in the burner flame at the point of original contact.

3. The glass which was pulled out is fused and blown out to a small bulb as shown in Fig. 33C.

4. The small bulb is reheated and blown out to a large sphere, Fig. 33D. The glass of the sphere is scraped away and the edges are fire-polished.

5. An open tube with a point is attached to the fabricated tube by the procedure of butt sealing. The joined sections are shown in Fig. 33E.

6. The other end of the vertical tube is closed with a cork. The seal is completed by fusing the glass around the entire circumference of juncture of the two tubes with a pin-point flame. The fused collapsed glass is expanded by

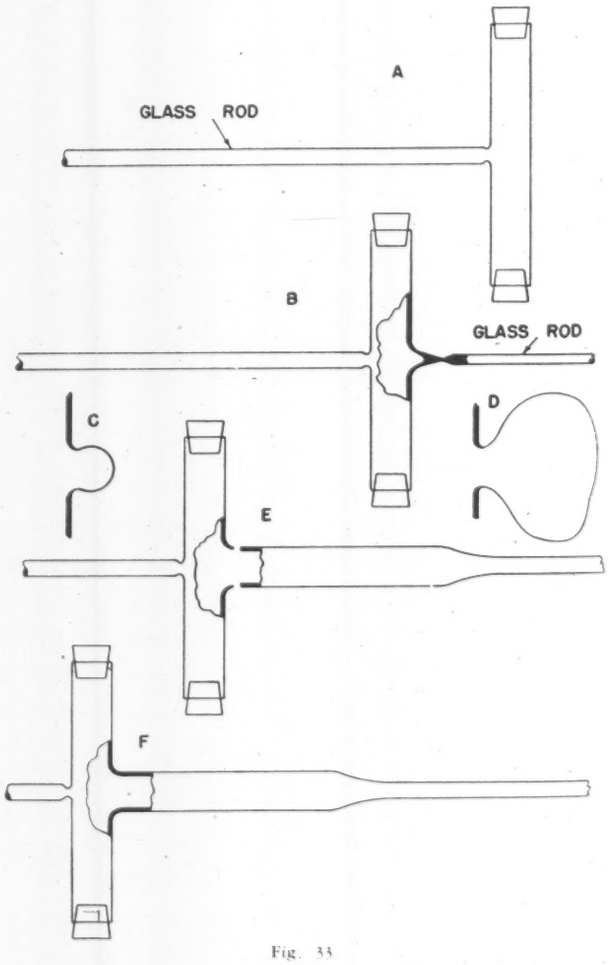


Fig. 33

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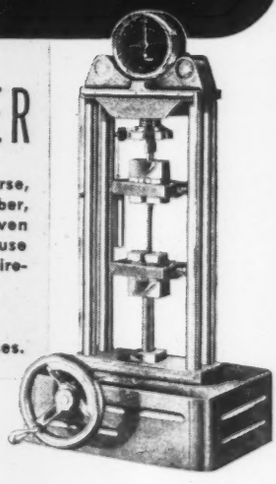

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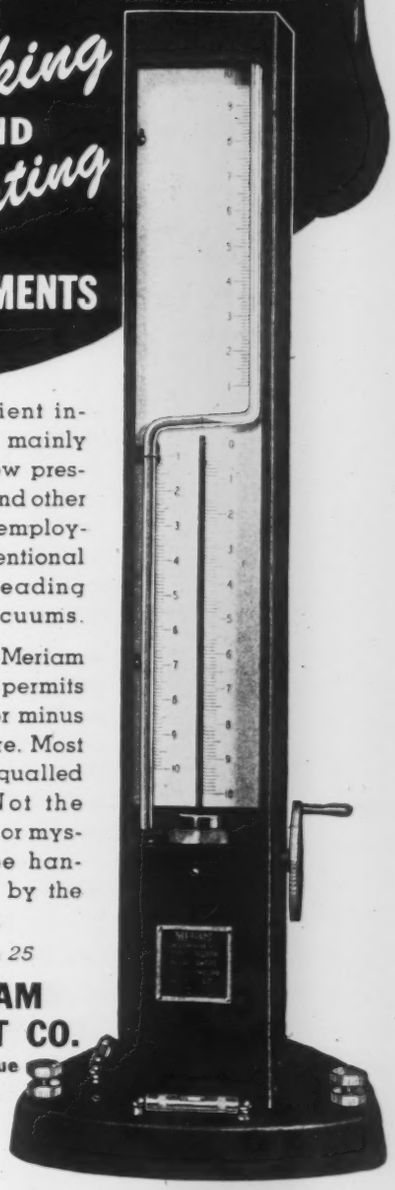

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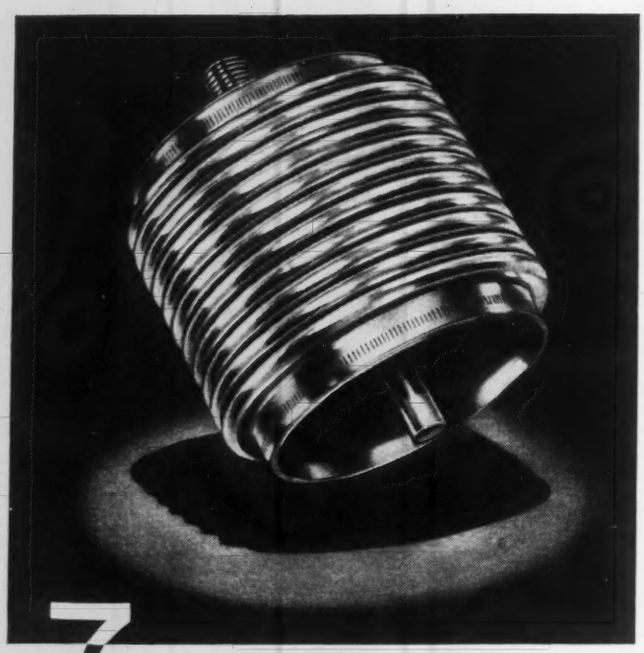

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blowing through the open point end. The finished seal is shown in Fig. 33F.

7. The rod is cut away from the vertical tube with the flame and the small irregularity caused by removing the rod is worked until smooth.

The above procedure in making side seals cannot be used when such seals are necessary on large or complicated glass sections.

The next technique to be learned is the rotation of the glass by holding the tube. This procedure is the recommended method of making side seals and will require practice in holding the joined tubes in the flame while rotating the glass in an arc of about 200°. The procedure is as follows:

1. An opening is blown in the wall of an 8″ length of glass tubing as described under steps 2, 3 and 4 of the preceding exercise. The opening in the tube should match the diameter of the tube which is to be sealed to the former.

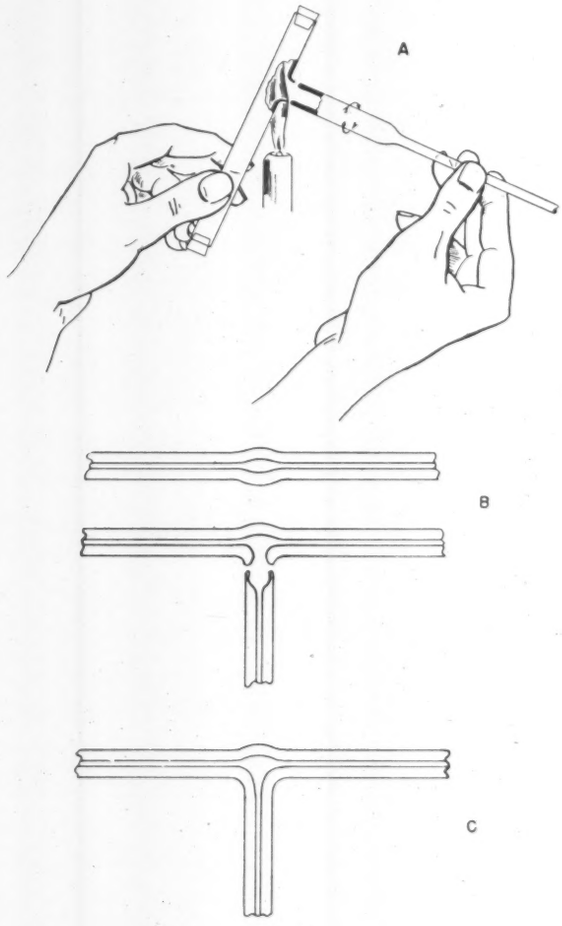

Fig. 34

2. The side tube is held in the right hand while the other is held in the left. The sealing edges are fused sufficiently and joined carefully to be certain that no pin-holes are left at the seal. The assembly is held in the flame as shown in Fig. 34A. The tube in the left hand is turned through an arc of 200° as the flame impinges at all times at the point of the joined tubes to insure even heating.

One should be careful not to heat the tube held in the left hand but rather to fuse the one held in the right hand sufficiently so that glass for the seal can be obtained by pushing the side tube slightly toward the joined section. This glass can then be expanded by air pressure and drawn to a uniform wall thickness.

It should be pointed out that whenever seals are made which require additional glass from one of the sections to

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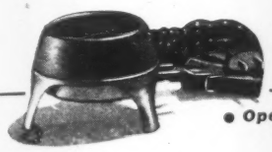

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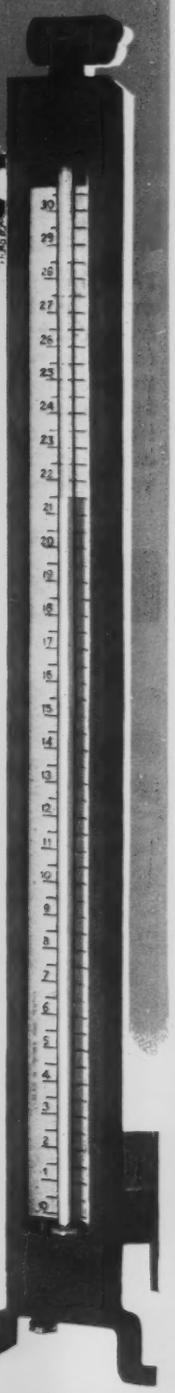

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be joined, it is always best to work the glass slowly toward the point of the seal. The glass can then be worked sufficiently to insure a good joint and be drawn to a uniform wall thickness.

Capillary Side Seals

The technique of making side seals or capillary tees is slightly different from that described under tubing side seals. The sequence of steps is as follows:

1. A ½" section of the capillary tube is heated with rotation in the burner flame and blown out, Fig. 34B. The wall thickness of the bulb should be nearly that of the original capillary and with an internal diameter slightly greater than the capillary bore.

2. A spot on the center of the bulb is heated with a pin-point flame until the glass is fused. A glass rod is attached to the fused glass which is then drawn out to a cone-shaped form. The rod is cut away at the point of the cone. This cone of glass is heated and blown out to a small bulb which is reheated and blown out to a large thin-walled bulb. The excess glass is scraped away with forceps and the opening is fire-polished. The opened tube is shown in Fig. 34B.

3. The procedure of opening a capillary tube has been discussed and shown in Fig. 31. A tube is fabricated as described in that section.

4. The capillary tube is sealed to the capillary with the side opening by using a pin-point flame. Only the glass at the seal should be fused. When large flames are employed, there is some danger of deforming the capillary tubing. The seal is completed by working the glass to uniform bore diameter.

Round Bottom Closures and Bulbs

The glass blower frequently finds that in the fabrication of glass equipment, round bottom closures are required. The technique of making such closures is relatively simple:

1. A point is drawn on the tube by the technique described under point pulling, Fig. 35A.

2. The tube is heated at the shoulder and drawn slightly with the point to the shape shown in Fig. 35B. The glass

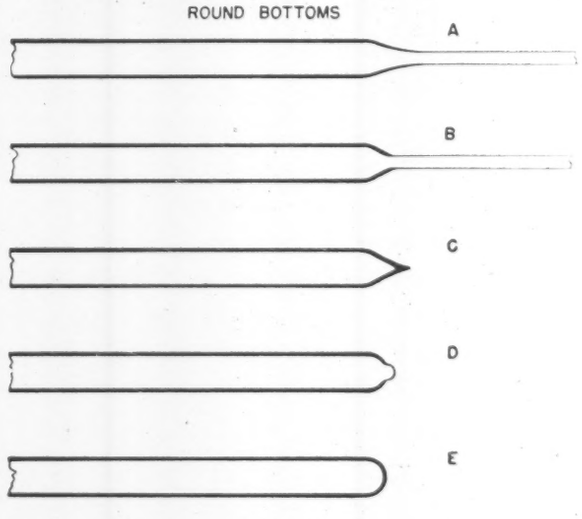
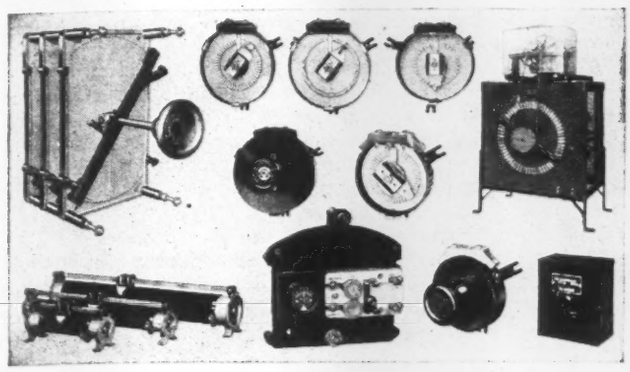


Fig. 35

should not be drawn too much, because the wall thickness of the cone should be identical with that of the tube.

3. The glass is cut with the flame at the cone apex by heating this zone until it is fused, and drawing away the point to form a tip as shown in Fig. 35C.

4. The tip is fused until the glass flows back toward the apex of the cone. This fused glass is then blown out into a small bulb having a wall thickness comparable to that of the cone, Fig. 35D. This step is important because if the wall thickness in parts of this bulb vary, it is hard to obtain a smooth rounded end. If imperfections in wall thickness are noticeable, it is best to fuse the bulb again and



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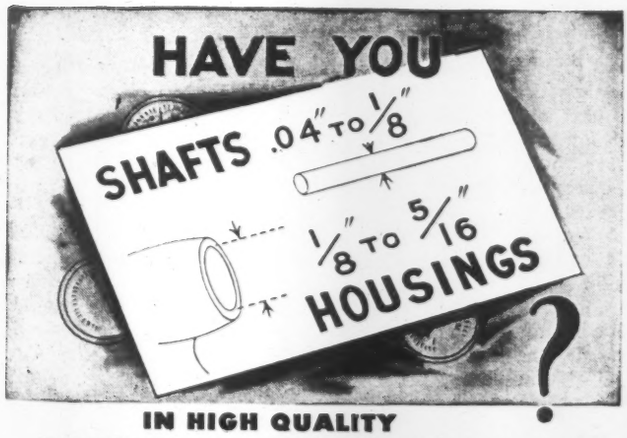

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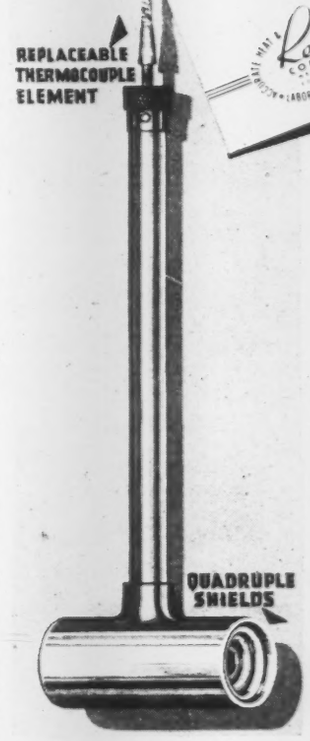

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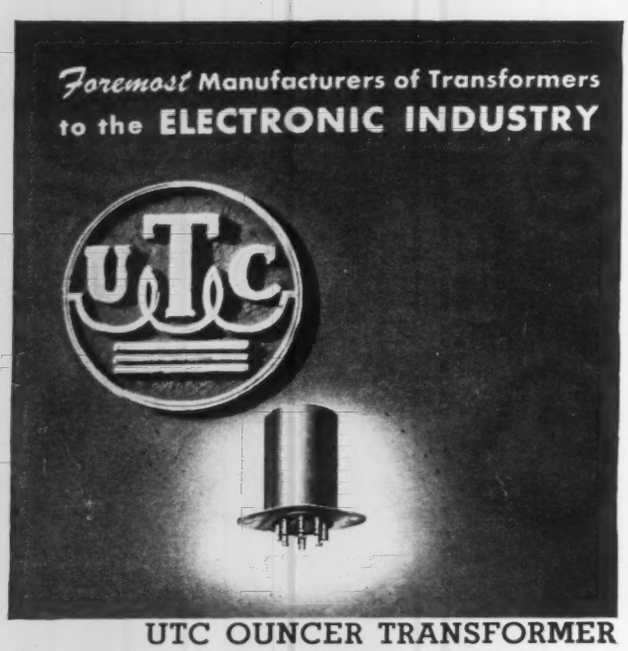

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blow it out as described. The worker will find that timing in blowing the small bulb is necessary.

5. The cone and bulb are then heated in a medium flame under uniform and continued rotation until the glass is partly fused. The glass is blown out by holding the tube upward. The glass must never be blown out greater than the diameter of the glass tube. Any irregularities in the contour of the tube end are caused by uneven heating. The finished tube is shown in Fig. 35E.

When tubes of large diameter are closed as described above, sufficient heat must be concentrated at the end of the tube prior to the final blowing. A 4"x4"x6" wooden block fitted with a handle for holding is ideal for deflecting the hot gases of the cross-fire flames against the glass. The block is held about an inch from the closed end of the tube.

Bulb at The End of a Tube

The process of fabricating a bulb at the end of a tube is an extension of the method used in making round-bottomed closures.

1. The tube is closed as described under the procedure of making round tube closures, Fig. 36A.

2. If a bulb of normal wall thickness is desired, sufficient glass must be fused along the tube to give a section of

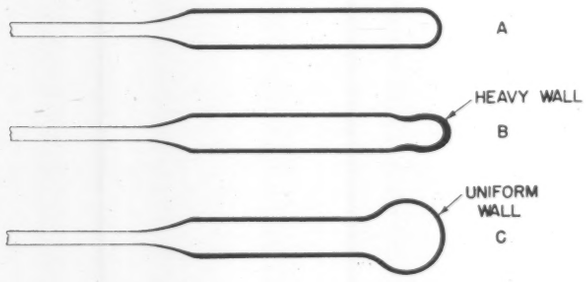


Fig. 36

thick-walled glass. The tube end is rotated in the flame by holding the point in the left hand and at an angle so that gravity and surface tension both tend to cause the fused glass to flow back toward the point. The fused tube end must not be allowed to sag. The tendency to deform in this manner is minimized by holding the tube at an angle nearly perpendicular to the horizontal, or to hold the point end above the horizontal to make the glass flow in the desired direction. The appearance of the fused section is shown in Fig. 36B.

3. When the tube is taken from the flame it must be held so that the bulb formed is truly round. This is accomplished by holding the tube end up while it is slowly expanded by blowing into the open end. The tube should be continually rotated. If a thick-walled bulb is desired it is also necessary to hold the bulb down, encouraging the flow of glass away from the tube.

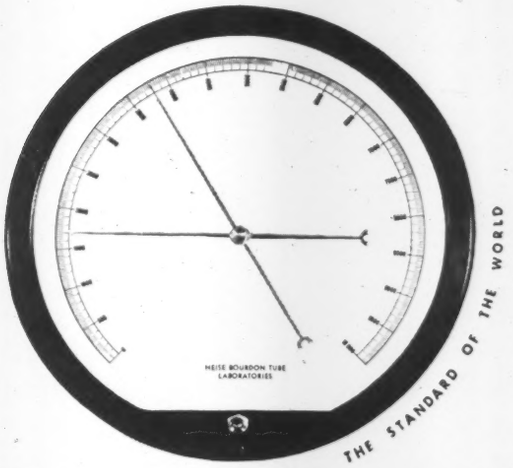
Bulbs in The Middle of a Tube

The production of bulbs in the center of a tube section requires considerable dexterity in rotating the tube while the glass for the bulb is being accumulated. The rotation of the tube by both hands must be uniform, with no twisting of the fused glass. It is advisable to use a blowing tube with a swivel to avoid deforming the fused tube. The blowing tube is connected to the end of the tube held in the left hand while the other end of the tube is closed with a stopper. The amount of glass required for the bulb will depend on its desired size and wall thickness. This glass is accumulated as described in the following exercise:

1. The tube is rotated in the burner flame until a section is collapsed as shown in Fig. 37A. One should guard against pulling or pushing the glass during this operation.

2. The fused section is removed from the flame and blown out as shown in Fig. 37B.

3. The tube is then fused as described under (1) at a section adjacent to the blown bulb. This fused glass is



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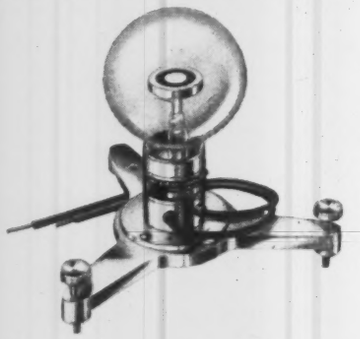

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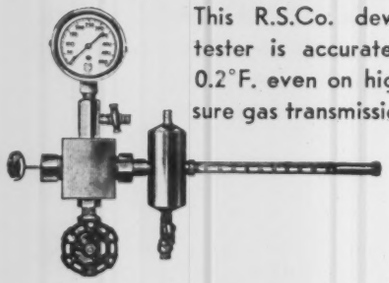

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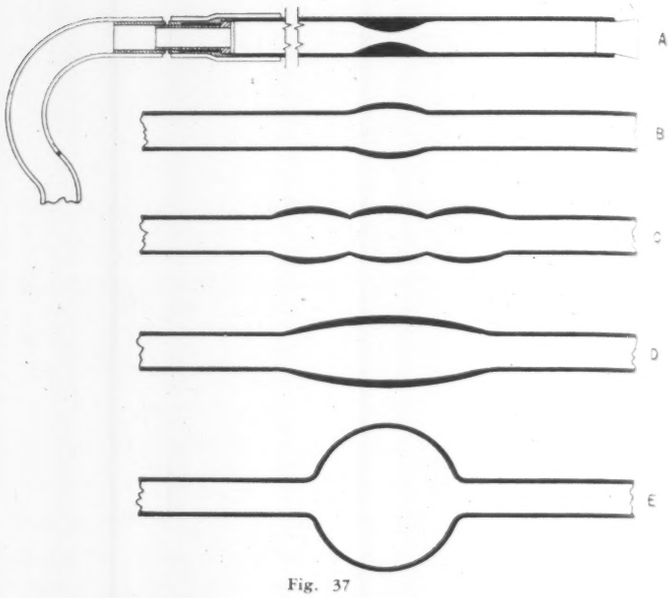


Fig. 37

blown out to a bulb comparable in diameter to the first. This procedure is repeated the third time until the final form is as shown in Fig. 37C.

4. The worked portion of the tube is then fused in a large bushy flame until the fused glass has a uniform wall thickness, Fig. 37D.

5. The glass is then blown out to a sphere as shown in Fig. 37E.

There is a definite limitation to the size of the bulb that may be blown as described because of the dexterity required in handling large sections of fused glass. The walls of bulbs blown in this manner usually are thin and no additional outlets can be sealed to the bulb.

Thick-walled bulbs are more easily fabricated by using a tube with a diameter equal to that of the bulb.

1. As an example, suppose a bulb of 2″ diameter is required with two opposite tube connections of 8-mm. diameters. A short section of 51-mm. tubing can be used by placing it on a fabricated holder. Asbestos tape is used as a packing medium. The open end of the tube is closed as described under round-bottomed closures. The fabricated tube is shown in Fig. 38A.

2. The tip of the round bottom is heated by rotating the tube until a small portion of glass is fused. This glass is drawn out to a cone with a glass rod, Fig. 38B. The cone is opened by fusing and blowing to a small bulb equivalent in diameter to the 8-mm. tube. The tip of this bulb is heated

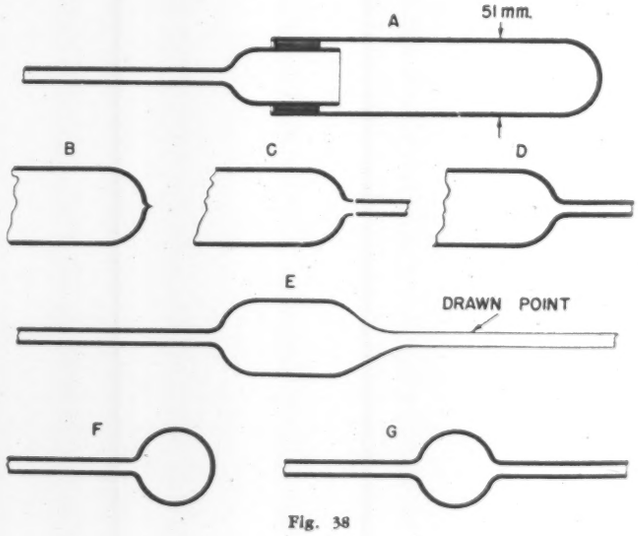
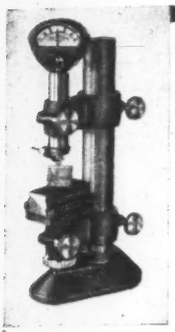


Fig. 38



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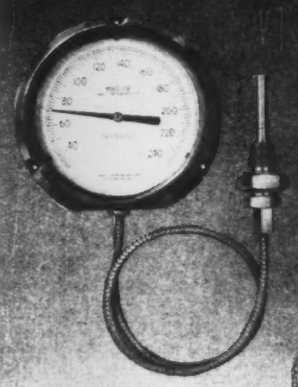

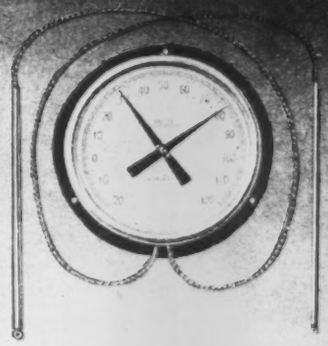

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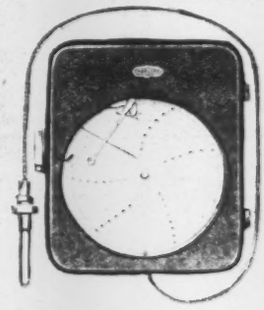

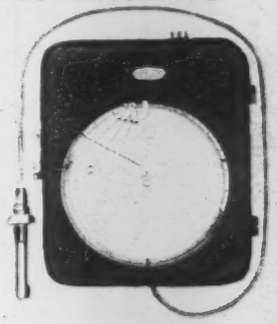

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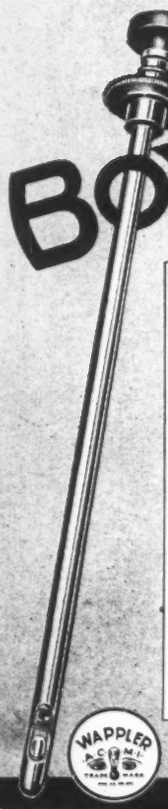

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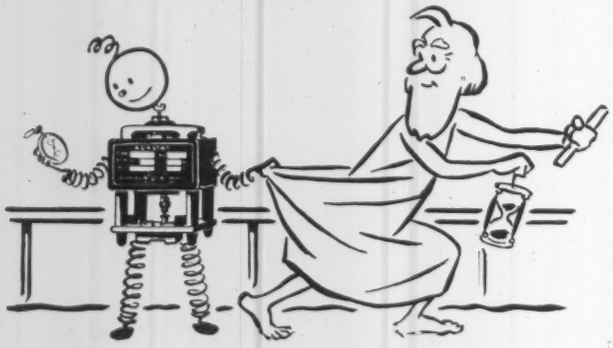

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until the glass is fused back to the maximum diameter of the small bulb and then blown out to a large thin-walled sphere. The glass of this sphere is brushed away with forceps and the opening is fire-polished. The 8-mm. tubing is then sealed to the rounded bulb, Fig. 38C, by the procedure of butt sealing, Fig. 38D.

3. The 8-mm. tube is held in the left hand and the large tube is heated just beyond the point, which is to be the maxium diameter of the bulb. The tube is drawn down, Fig. 38E, and the end is closed as described under the fabrication of rounded tube closures, Fig. 38F.

4. The tip of the bulb is then fused and the same procedure as given under (2) is followed in sealing the second tube to the bulb, Fig. 38G.

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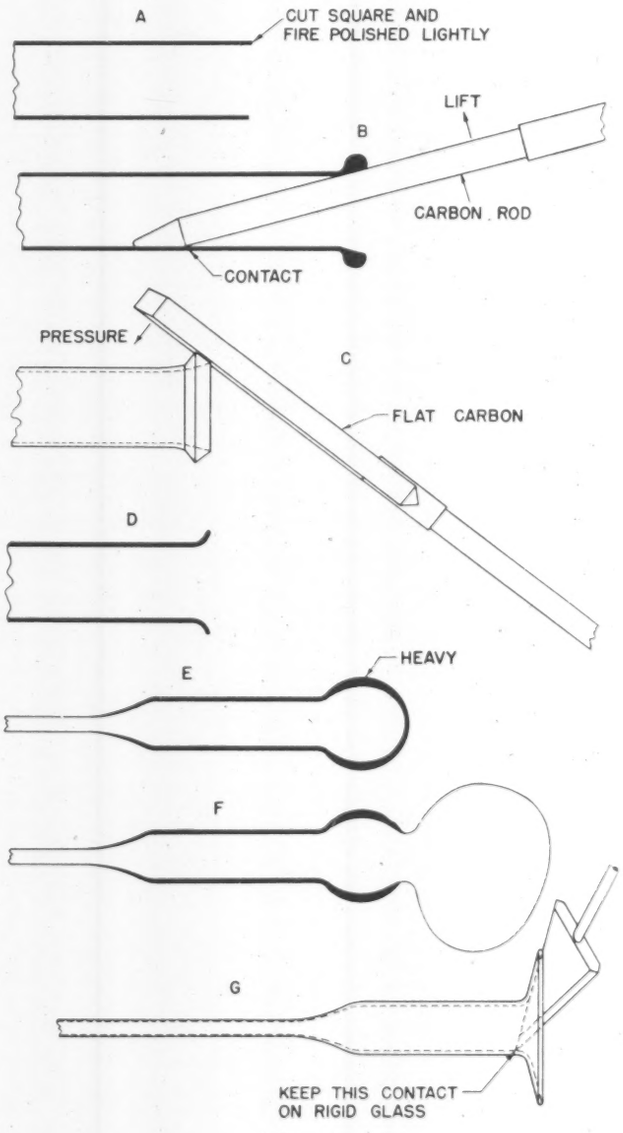

Fig. 39

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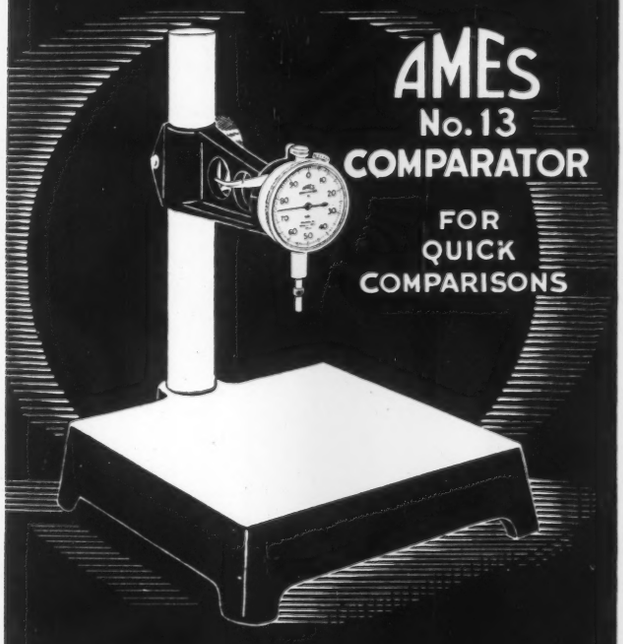

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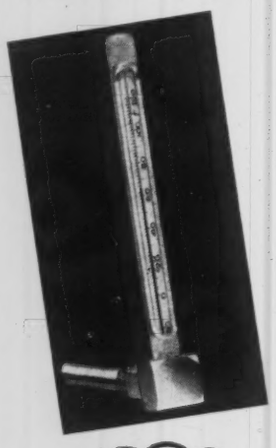

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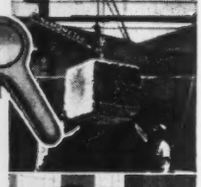

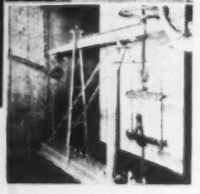

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an abrasive wheel or hot wire cutter and fire-polished until the edges are smooth, Fig. 39A.

Reinforced and Tapered Ends.—Sometimes it is necessary to reinforce the end for stoppers. This may be accomplished as shown in Figs. 39B and 39C. The tube end is fused by supporting the glass on rollers and heating the glass sufficiently so that surface tension causes the glass to accumulate at the end. This glass is then worked with a round carbon tool, Fig. 39B. The point of contact of the end of the tool is on the cooler side of the glass which makes it possible to apply a little force in forming the fused portion.

Beaded Ends.—Another method for preparing a tube end is shown in Fig. 39C. The end of the tube is prepared as shown under Fig. 39B. The glass is allowed to cool until rigid. The very tip of the end is then heated in a hot flame and shaped as shown in the drawing. The entire bead should not be fused in this operation because of the danger of greatly restricting the opening. Even under the most carefully controlled conditions it is necessary to heat the end sufficiently to permit opening of the end with a standard taper. The tube, however, should not be so heated that the square end will be deformed. Heavy ends should be carefully annealed after they are completed.

Curved Ends.—A tube end with a curved edge comparable to test-tube ends is fabricated by fusing the very end of the glass just to the point where it can be worked to a flared end, Fig. 39D. The glass must not be allowed to thicken as was required in preparing the tooled ends discussed above.

FLARED ENDS

Flares on tubing ends have other uses as well as serving as a finished end. The limitations of the width of the flare are determined by the diameter of the tubing. In making large flares on small tubing the expedient of expanding the end of the tube to a thick-walled bulb is used, rather than attempting to spin out the small diameter tubing to a large heavy-walled flare. The recommended method of flare fabrication is as follows:

1. A strong and truly axial point is drawn on the tube. This is important since the non-axial points will cause poor and irregular flares. The tube is held by the point in the left hand and the outer edge of the end is softened by partial fusion. The flat-pointed tube is applied horizontally into the end of the tube, by the right hand, with a gentle pressure against the side of the tube as it is rotated in a clockwise and counter-clockwise movement. The tool is gradually swung upward toward the left hand so that the flare is gradually worked to the desired form, Fig. 39G. The flare is formed, not by heating it entirely as it is made, but rather by working it from outer flare edge to the tube by heating circular portions of the flare. Pressure on the tool is carefully controlled in shaping the glass which must

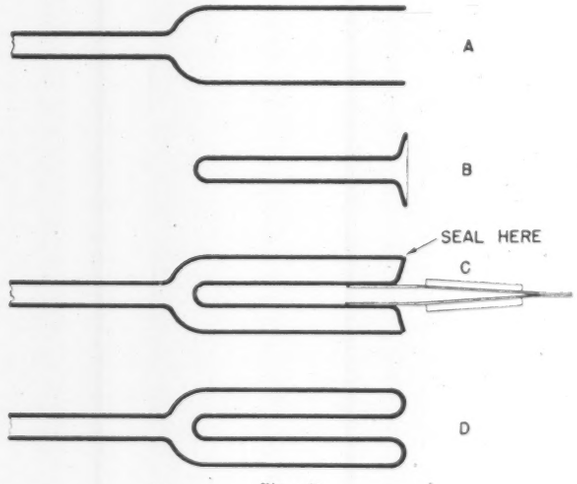

Fig. 40

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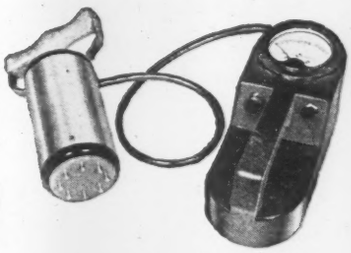

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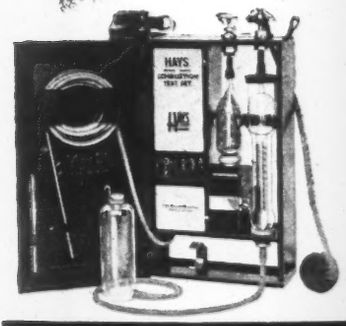

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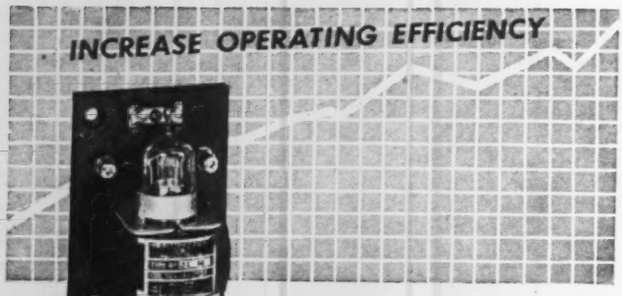

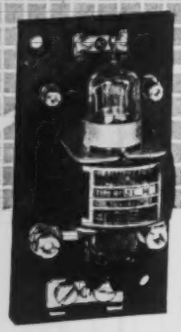

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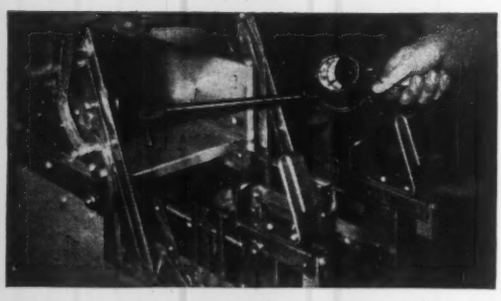

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be soft enough to be gently shaped at the slightest contact of the tool. Increasing the pressure will deform the glass.

On some occasions it is necessary to make wide flares on tube ends. This can best be accomplished as follows:

1. A truly axial point is drawn on the tube which is in turn closed and blown into a thick-walled bulb, Fig. 39E.
2. The bulb is cut open by fusing the glass from the tip to the maximum diameter of the bulb. This fused glass is blown out to a thin-walled bulb, Fig. 39F. The thin glass is scraped off and the edge is fire-polished.
3. The flare is then completed as described above and shown in Fig. 39G.

Flare Sealing

The flared end is used in an application where one tube is to be sealed within another tube of larger diameter. This seal is made by the following procedure:

1. A point is drawn on one end of the larger tube. The other end is opened to a square end with the burner flame, Fig. 40A, as was previously described.
2. A flare with a diameter equivalent to that of the large tube is made on the smaller one. The end opposite the flare is closed to a round bottom, Fig. 40B.
3. The flared tube is placed inside the larger tube by supporting the former with forceps, Fig. 40C. The two edges are fused together and the forceps is removed. The seal is worked by heating with uniform rotation and blowing out the collapsed glass. *Important:* When the glass at the seal is soft, the inner tube will have a tendency to sag and must therefore be balanced by clockwise and counter-clockwise motion. Should the inner tube become constricted, it can be opened only by applied pressure with a round carbon rod held against the top of this tube. Enlargements on the outer tube can be worked to the tube diameter with a flat carbon tool. When completed, both tubes should be symmetrical, Fig. 40D. The seal is carefully annealed.

(To be continued)

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This is to remind our readers that *Instruments* pays $5 (or more*) for each shop kink or other time-saving and accuracy-promoting idea accepted for publication.

The following rules must be observed:

1. Type double-spaced on one side of paper. Author's name and address at top of first page (envelopes get lost!)
2. Diagrams must be in black ink (no blueprints). Lettering (if not made with aid of machine) may be soft-pencil, to be inked-in by *Instruments*.
3. Only professional-grade photos will be accepted (preferably 5 x 7 or 8 x 10 glossies).
4. Each contribution to describe ONE method or device. An author may send as many as he likes.
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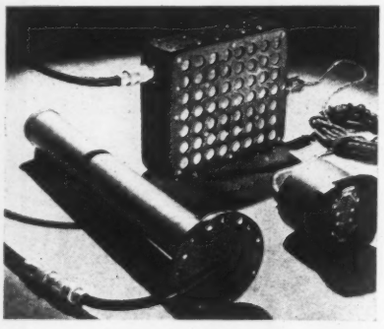
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department. Or write to Information Section, Instruments Publishing Company.

Variable-capacitance Type Aircraft Fuel Gaging System

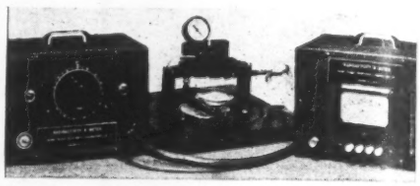
New "Pacitor Gauge" is accurate to within 3% and is unaffected by changes in flight attitude, or temperatures. A



non-electronic principle is utilized in primary elements, namely change of capacitance when the dielectric changes from liquid to air. These primary elements or "tank units" are in the form of concentric metallic tubes insulated from each other: when tank is full, fuel is the dielectric; when tank is empty, air is the dielectric. Measuring circuit includes reference capacitors and cockpit indicator is a d-c. ratio meter. Electronic components are a single-tube oscillator generating a frequency of 10,000 c.p.s., and rectifier tubes. Tank units, power supply and cockpit indicator are interconnected by standard electrical fittings and may be arranged in a circuit to meet requirements of any type of installation. Accurate totalizing of the readings of many irregularly-shaped tanks, located in wings and fuselage, is said to be a further advantage. The only moving parts are the usual moving parts of the d-c. movement in the cockpit indicator.—*Simmonds Aerocessories, Inc., 30 Rockefeller Plaza, New York City.*

Radioactivity Meter

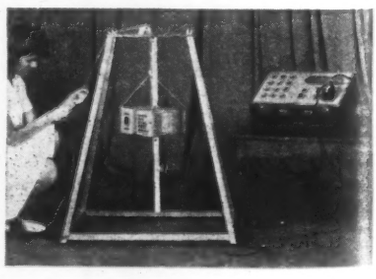
New "Type RM82 Radioactivity 'R' Meter" is designed for measuring directly, extremely weak radiations from small quantities of radioactive materials. It will indicate values from 0.000001 to 20.0 "R" units. In spite of this exceptionally high sensitivity, it is said to be fully stable and simple to operate: experienced or learned personnel are not required. It is calibrated directly in fractions of "R" units on a linear scale of a 4" indicator. It has five "R" ranges which are quickly



selected by push buttons. Full scales on these ranges at maximum voltage are: 0.0001, 0.001, 0.01, 0.1, and 1.0 "R" units. By using minimum voltage the least sensitive range can be extended to 20 "R" units for full scale. Indicating instrument proper is said to be "an electronic device" which measures currents as low as 0.001 of a microampere. A high-voltage power supply with adjustable output from 100 to 2000 volts d.c. is part of the apparatus. Safety switches prevent operator being exposed to required high voltages. Various types of units are employed for holding the chemicals to be measured. Illustration shows one of several arrangements: material holder and electrodes enclosed in a bell jar for evacuation. This is not necessary but often desirable. Equipment is enclosed in two steel cases, each approx. 11" wide × 8" high × 8" deep. Apparatus operates from 60-cycle 115-volt a.c. supply. — *Rowe Radio Research Laboratory Co., 2422 North Pulaski Road, Chicago 39, Ill.*

Accelerometer for Shock Measurements

New "Cushioning Meter" is said to offer a simple, rapid, and dependable means of determining correct type, amount and distribution of cushioning material to protect any article in shipment. It measures, in standard terms, the shock experienced by the object packed. Equipment consists of a detector head and an indicator. Detector head contains an electrical mechanism which responds to shock it experiences. Its response is transmitted through a



flexible cable to the indicator on which it is registered by the energizing of neon glow lamps marked to correspond to the peak shock expressed in *G*'s. It registers shock in twelve steps covering a range of 10 to 100 *G*'s. Indication is accurate to 1*G* on any step. Indicator circuits operate from self-contained 110-volt 50/60-cycle a-c. power supply. In operation, detector head is attached to a mock-up of the article to be packed. Mock-up is dropped on a hard surface and peak shock is read from indicator. Lamps on indicator glow until a manual reset button is pressed, hence operator need not watch an instrument pointer to catch a peak deflection. Indicator and power supply are housed in a carrying case with a hinged cover and a leather handle. Indicator case is 16½" × 11" × 9" and weighs 17 lbs.; detector head is 2" square × ⅝" thick; weighs ½ lb.—*Meter & Instrument Div., General Electric Co., West Lynn, Mass.*

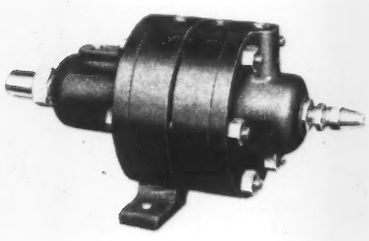
Geiger Counter Tubes

CORRECTION

Reference to new types "TA-B1" and "TA-B2" (*Instruments*, Dec. 1945, page 923): operating range is from 1400 volts to 2000 volts and reaction time is 3×10^{-4} second dead time. Also, in ninth line, for "surface as coated . . ." read "surface is coated . . ."—*Technical Associates, 3730 San Fernando Road, Glendale 4, Calif.*

Computing Type Pneumatic Relay

New "Type F Totalizer" is a pilot-operated pneumatic relay used to add or subtract loading pressures received from external sources. It is said to be of great versatility and is also used as a regulator. It requires for its operation a source of compressed air at substantially constant pressure. Sensitivity: device will effect a reproducible change in outgoing loading pressure on 0.1% change in incoming loading when output loading pressure is at maximum. It may be used in connection with a measuring flow element and a power unit to regulate fluid flow, temperature, pressure, level, speed, or any other physical condition that can be translated into a loading pressure. When used as an element in a control system, totalizer may perform any of the following functions: (1) Add or subtract loading pressures, thereby totalizing fuels to a boiler or furnace fired with multiple fuels, or setting up the flow of auxiliary fuels. (2) Average two or more loading pressures, thereby indicating air requirements for groups of burners or pulverizers. (3) Act as a selector for loading. Example, to control fan speed on basis of air pressure requirements of most-heavily loaded of several burners. (4) Respond to loading pressures sequentially, as when setting up sequence of operation of several different burners or fans. (5) Produce anticipating or derivative action. Used in this manner, totalizer may then be applied to overcome effect of storage in some control applications. (6) Operate as a safety relay. Example, to limit rate of firing of a boiler or furnace to that corresponding to maximum induced draft fan capacity. (7) Act as a pneumatic stop for diaphragm-operated valves, receiving regulators, etc. In some cases it may be desirable to limit maximum or minimum opening of valves or dampers under automatic control without interfering with ability to move these valves through their entire range under manual control. (8) Invert loading pressures: transmit a loading pressure moving in the direction opposite the change in loading received from external sources.—*Hagan Corporation, Hagan Building, Pittsburgh, Pa.*



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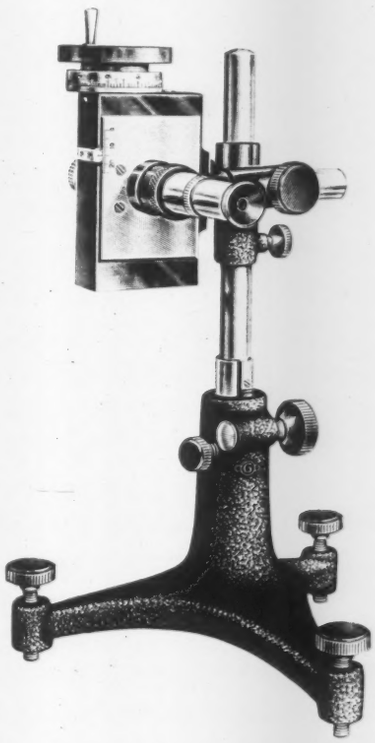

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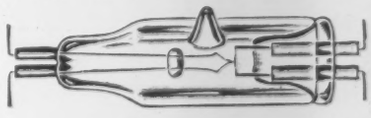

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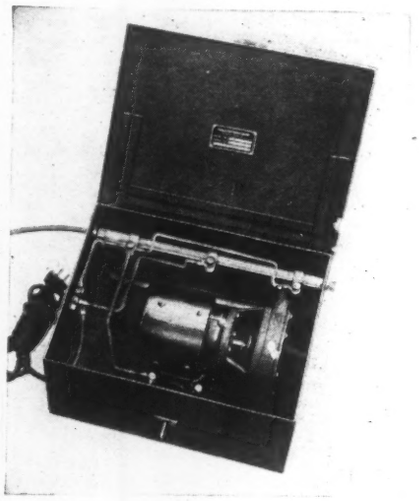
heater wires of extremely small diameter, and of non-magnetic composition; inductance and skin effect is thereby minimized. (2) Bringing out of heater and couple leads at opposite ends of glass bulb and keeping couple at right angles to heater; thus capacitive and mutual inductive coupling between heater and couple are minimized. (3) Use of an insulating bead between heater and couple; except for an extremely small capacitance through the bead, couple circuit is electrically isolated from heater circuit. (4) Reduction of length of heater and lead-in wires: complete length of the loop forming this circuit is only 1¼", giving it an extremely low residual inductance and capacitance. Electrical efficiency of new thermocouples is said to be such that inexpensive (ten to fifteen-dollar class) millivoltmeters which are sufficiently accurate for UHF work, may be used.—*Field Electrical Instrument Co., 109 East 184th St., New York 53, N. Y.*

Hygroscopic-color Labels

New "Hygrolabels" are small sensitized labels (smaller than a postage stamp) which change color with humidity. Color change is distinct, definite, and reversible—being a brilliant blue-green when dry, and pink when humidity causes mold, mildew, corrosion, rust, etc. "Hygrolabels" are furnished in the form of self-adhering labels supplied in roll and strip form upon a protective backing. Individual labels may be placed on, in, or between sheets of, the material to be checked. By removing the label from the protective backing it may be affixed to any surface. By leaving the protective backing in place the label may be placed into any powdered, granular or flaked material without contaminating the product.—*Eljay Enterprises, P. O. Box 891, Newark 1, N. J.*

Flow-type Conductivity Cell

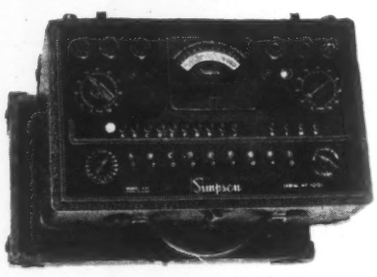
New "Type J" positive-flow type cell, developed for use with maker's electrolytic conductivity controllers and recorders, consists basically of a tubular



glass conductivity cell with concentric cylindrical platinum electrodes, and a continuous-duty stainless steel centrifugal pump. Unit is enclosed in a hinged steel case, is adapted for mounting either on outside wall of a tank, or on a remote instrument panel. Connection to liquid under test is made with ⅜" o.d. Saron or metal tubing. It is said that with this type of conductivity cell accurate measurements can be made even with rapidly-changing concentrations since forced circulation minimizes lag. Design is said to permit use of a cell of high cell constant where liquid is a good conductor—necessary in making accurate measurements in highly-conductive solutions. Since only part that must be immersed is a short length of small gage metal or plastic tubing, breakage of cells by moving parts in the tank itself is minimized. In conjunction with several small valves, a single "Type J" flow cell can be used to maintain a check on the contents of a number of tanks. —*Industrial Instruments, Inc., 17 Pollock Avenue, Jersey City 5, N. J.*

Tube Tester

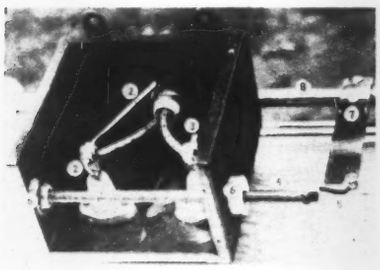
New Mutual Conductance Tube Tester is said to be "so revolutionary that it will start a new trend in tube



testing methods." A tube under test is compared with the standard rated micromho value for that tube. Colored zones on the dial coincide with the micromho rating or percent of mutual conductance, indicating that the tube is good, fair, doubtful or definitely bad. Maker declares that new tester reproduces more completely than ever before the actual conditions under which a tube functions in a radio set. Another feature is a new switching arrangement: circuit is so arranged that, even though numerous combinations are possible, very few switches require moving to test any one tube. Many tubes can be tested in "normal" position without moving any of the nine tube circuit switches. Ten push button switches and nine rotating switches of six positions each provide a multitude of combinations in tube element and circuit selection. A tube chart is provided for quickly identifying the tube and setting the controls. An automatic reset button returns all switches to normal when test is completed, rendering the tester instantly ready for a new test. Case is plywood with heavy fabricord covering, corners trimmed in leather; cover is removable. Over-all size is 15½" × 9½" × 6½".—*Simpson Electric Co., 5216 Kinzie St., Austin Sta., Chicago, Illinois.*

High-voltage Disconnect Switch

New high-voltage disconnect switch, completely enclosed in a 6" × 4½" × 4" iron box, is used to automatically disconnect static eliminating bars



when machine to which bars are applied is stopped by operator, where static-eliminating applicators on a group of machines are fed from one central high-voltage power unit. It is intended for use especially where machine is stopped by a manually-operated throw-off device. In photograph, switch box cover has been removed to show operating parts. Switch is open. Shaft 8 represents throw-off shaft of machine; 7 represents operating fittings supplied by customer. Throw-off shaft 8 is all the way to right and spring 5 has pulled Bakelite operating rod 4 all the way to right, thus rotating short arm of switch blade 2 to right and opening long arm of blade up all the way to iron cover, grounding the blade. Bakelite operating shaft 4 moves back and forth through porcelain bushings 6. When throw-off shaft moves to left, spring 5 moves Bakelite shaft to left until switch blade 2 makes contact with post 3 and switch is closed. Spring 5 takes up overtravel of throw-off mechanism. High-voltage cables are brought in through a porcelain bushing in back of box and fastened back of brass knurled nut terminals. Live terminal

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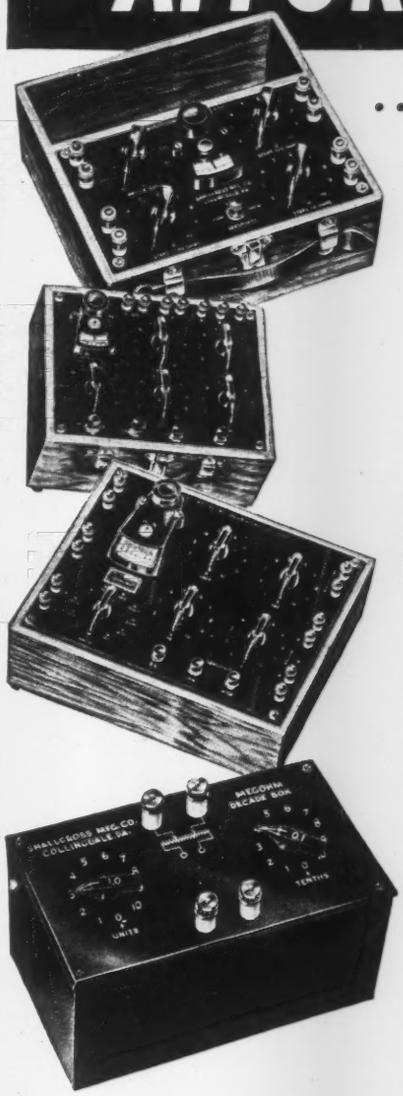

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Bulletin D-1, Bridges
Bulletin LRT, Low Resistance Test Sets
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▶ Proper furnace control demands absolute accuracy from the control devices. Beck Mechanisms provide it. Driven by a special motor, the armature of which revolves at less than 100 rpm, they offer all the advantages of slow-speed, yet move the valve from full-open to full-close at any speed suitable to the process. Non-mechanical magnetic braking eliminates coasting and the use of full instrument sensitivity is possible without "hunting." The large diameter motor shaft turns on oil-sealed ball bearings, to function unfailingly in either cold or hot locations. The motor can be stalled without damage to the mechanism and the stalled motor will not overheat. The unique features of this mechanism assure continuous operation at maximum sensitivity without need for adjustment.

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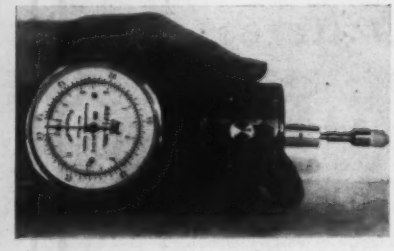
BECK MECHANISMS
for precise automatic control

HAROLD BECK COMPANY, 3642 North Second Street, Philadelphia 40, Pa.

is metallically connected to switch post; the other, connected to switch blade, feeds the static eliminating applicator. Switch may also be arranged to operate from a solenoid, actuated through a relay or from a push-button station.—*The Simco Company, 4929 York Road, Philadelphia, Penna.*

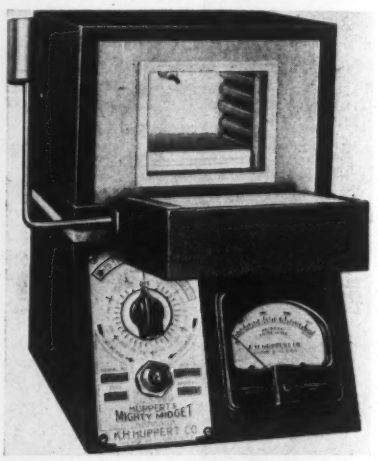
Hand Tachometers

New models of precision hand tachometers operate on centrifugal principle, cover a 1-to-40 range of speeds in five ranges selected by a knurled ring. The four models are: "Model A," 30 to 12,000 r.p.m.; "B," 45 to 18,000 r.p.m.; "C" 60 to 24,000; and "D," 120 to 48,000 r.p.m. It is thus possible to obtain the speed of generators, combustion engines, belts, elevators, transmission pulleys, power plants, textile machines, pumps, lathes, etc. It is said that these tachometers gain their extreme precision from the fact that each dial is individually calibrated for each instrument, so that speeds of revolving shafts can be measured as close as 1 r.p.m. In "Model A," the hand reads to 1 r.p.m. and fractions may be estimated. In the 100-to-400 range each graduation shows five revolutions; in 300-to-1200, ten; in 1000-to-4000, fifty; in 3000-to-12,000, one hundred. Attachments are provided to give feet per minute.—*George Scherr, Co., 200 Lafayette St., New York 12, N. Y.*



Small Electric Furnace With Balanced Stepless Control

New "Mighty Midget" has inside dimensions of only 3" × 3" × 3"; O.D. 8½" × 10½" × 8½"; is said to represent a complete departure from accepted laboratory and small-unit production furnace standards. It is equipped with built-in automatic control said to maintain any desired temperature in the furnace range (200°F. to 1750°F.) with "accuracy of high-priced large-capacity production furnaces." Extremely low operating costs are said to be experienced as a result of precision control which balances power input to heat demand. Furnace operates on 110 a.c. with current consumption of 500 watts. Integral incorporation of maker's balanced stepless control into basic furnace design produces a compact unit; eliminates additional investment of controllers and extra mounting panels, wiring, etc. Among features: all-steel construction; multi-insulation; high-temperature alloy elements; indicator light, and indicating pyrometer. New control features of "Mighty Midget" are also being added to a number of maker's larger furnaces.—*K. H. Huppert Co., 6830 Cottage Grove Avenue, Chicago 37, Illinois.*



Accelerometer for Shock Measurements

New "G Meter" is so designed as to read value of maximum intensity of shock, even though maximum is of extremely short duration. Equipment consists of two parts: "G Meter" itself which is subjected to the shock, and electronically-operated indicating mechanism. Indications are provided by means of a series of lights which represent gradations of shock. Thus, for a given impact, the number of lights glowing represents the maximum instantaneous shock experienced by the "G Meter". Equipment may be used to determine the shock involved due to vibration even at relatively high fre-

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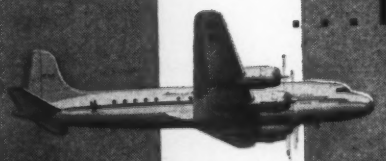

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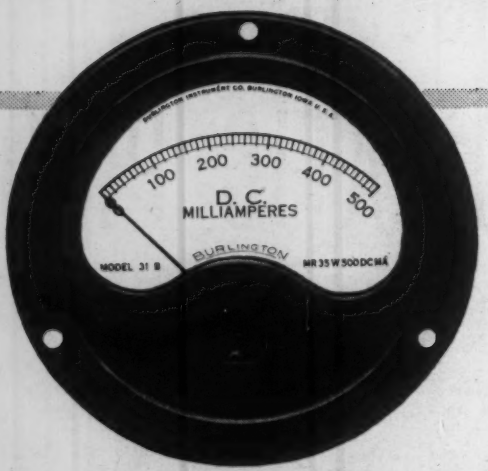

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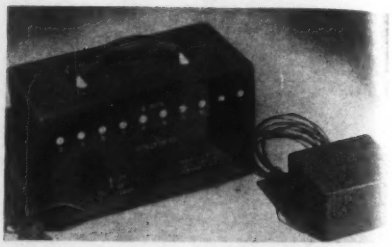


quencies, or for determination of shock transmitted to various components of any moving mechanism. In vibration tests, actual shock may be determined in addition to usual practice of measuring only amplitude and frequency. The shock experienced by any part of a car or plane may readily be determined. In studies of packaging of materials, "G Meter" is securely incorporated in a mock-up of the article whose packing is to be tested. Size and weight are adjusted to simulate the article itself. This mock-up is then wrapped; completed package is dropped a known distance and reading obtained is a direct indication of shock transmitted through package. If desired, shock transmitted may be correlated to total shock administered, and degree of shock insulation of particular package calculated. Different types of packing may then be investigated and compared. Since the degree of shock which safely can be tolerated varies for different commodities, range of instrument supplied is in accordance with the particular requirements. — *Frederic D. Schottland, 82-62 Grenfell Ave., Kew Gardens, N. Y.*

Edge-penetrator Hardness Tester for Screw Threads

New application of cemented carbides to hardness testing is announced. For a number of years solid Carboloy balls have been used in Brinell machines, particularly for checking hardness in higher ranges. In new application, the use of Carboloy cemented carbide permits checking of comparative hardness inside small bores. Actual application is checking of hardness of threads in castellated aircraft engine nuts. Carbide is "edge" pene-

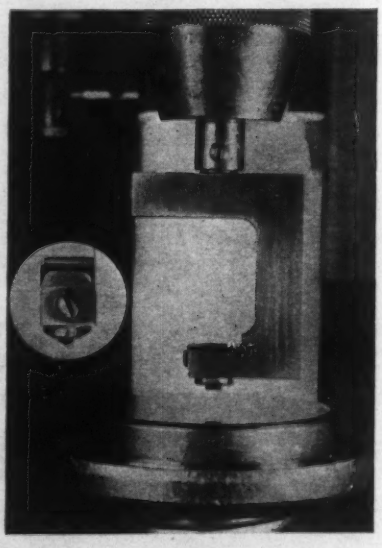


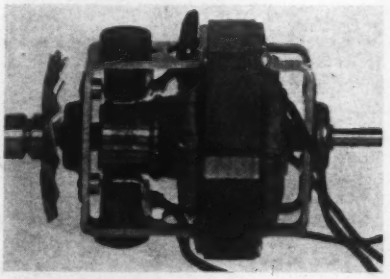
Fig. 1.

Fig. 2.

trator mounted in a C-extension arm on a Rockwell machine (Fig. 1). It has an obtuse angle with a 0.010″ radius at edge (see insert). Modified "C" shaped steel holder is attached to the Rockwell machine as shown in Fig. 2. This arrangement enables carbide edge to contact internal threads of nuts being checked. Conventional Rockwell scales cannot be used, of course. Readings obtained are relative; scale used is based on readings taken from checks of acceptable and non-acceptable threads. Use of a Carboloy edge penetrator prevents indenting or nicking of the testing edge, as would be the case if steel were used in a similar manner. — *Pratt & Whitney Aircraft Div. United Aircraft Corp., East Hartford, Conn.*

Fractional-hp. Universal Motors

New "V Series" of fractional-horsepower universal motors, for continuous service as in some instruments, are de-



signed for optimum cooling with maximum power output, by means of a ten-bladed fan and open laminated construction. "VC" type motors are rated at 125 volts a.c. or d.c., have an output of 1/100 hp. at approx. 7500 r.p.m., are non-reversing, with clockwise rotation of shaft at fan end. With a ½″ stack, "VC" motor has an over-all length of 3-21/32″, and is approx. 2⅛″ in diameter. On standard motors, shaft at fan end is fitted with a 15/32″ pulley. (Special shafts or pinions may be supplied.) "VD" motors are rated at 125 volts a.c. or d.c. and have an output of 1/30 hp. at 7500 r.p.m. With a 1″ stack, over-

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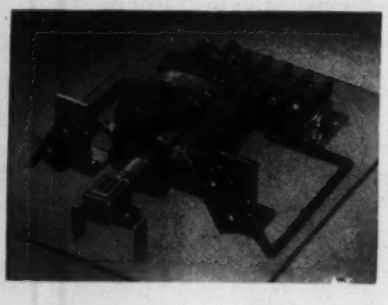
Hathaway INSTRUMENTS

all length is 4⅜" and diam. approx. 3". Other specifications are similar to the "VC." Lead wires on "V Series" motors are 20# B. & S. Ga., 8" long, plastic insulated. In addition to special output shafts, other optional features include a radio interference capacitor, and mountings for a variety of installations.—*Lear, Inc., 110 N. Ionia Ave., N.W., Grand Rapids, Mich.*

Timing Contactor

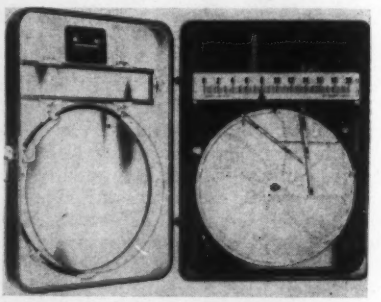
New timing contactor was developed for testing electrically-operated mechisms such as solenoids, relays, etc., particularly where break-down or life tests are desired, but has numerous other uses. It consists of a synchronous motor (available in various speeds) and two Micro Switches operated by a cam disk fastened to the motor shaft. It can be operated continuously for an indefinite time without attention. By using disks with various numbers of cams,



and motors of various speeds, the number of makes and breaks per minute is practically unlimited. Although this unit is particularly valuable for life tests, it can also be used where contacts are to be opened and closed regularly. Terminals are provided for easy wire connections, and two switches are standard equipment so that two tests can be run at the same time. The counter, for short runs, is optional. The unit is portable, and may be plugged in anywhere. It has no tubes, and no intermediate contactors are necessary. All items are mounted on a steel back plate and come enclosed in a 9" × 12" × 4" sheet metal case finished in black wrinkle enamel.—*B/W Controller Corp., Birmingham, Mich.*

Proportional Current Input Controller

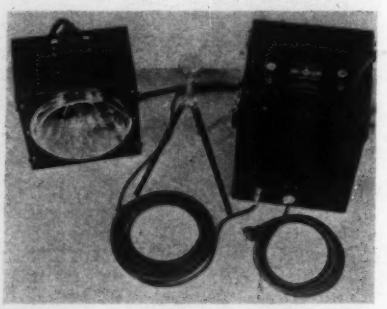
New electric type automatic temperature controller combines in one case a proportional current input controller and a recorder. Designed to provide



extremely accurate control of electrically-heated furnaces and ovens, new instrument provides on-and-off type control with advantages of proportioning control. A rotating cam interrupts the flow of current to heating coil or coils, duration being determined by departure of controlled temperature from control point.—*The Bristol Company, Waterbury 91, Conn.*

Light Source for Ultra-high-speed Photography

New "Microflash" is a light source for photographic exposures of the order of two microseconds. Originally de-



signed for war use in development and test of new types of ammunition, new stroboscopic instrument has many applications in industry to provide both knowledge and a record of mechanical phenomena occurring in a very small fraction of a second. It consists of a power supply, which charges a capacitor to a high voltage, and means for

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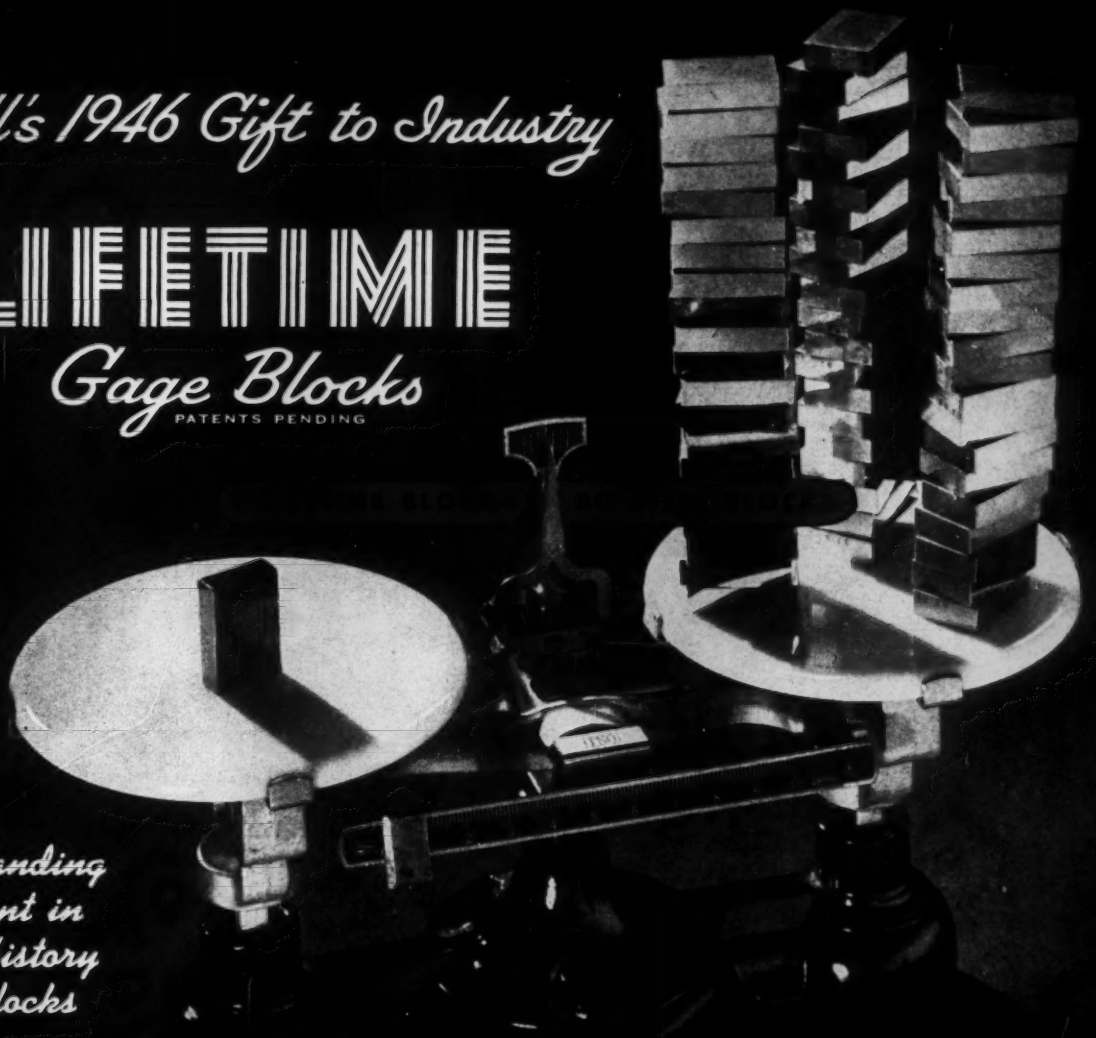

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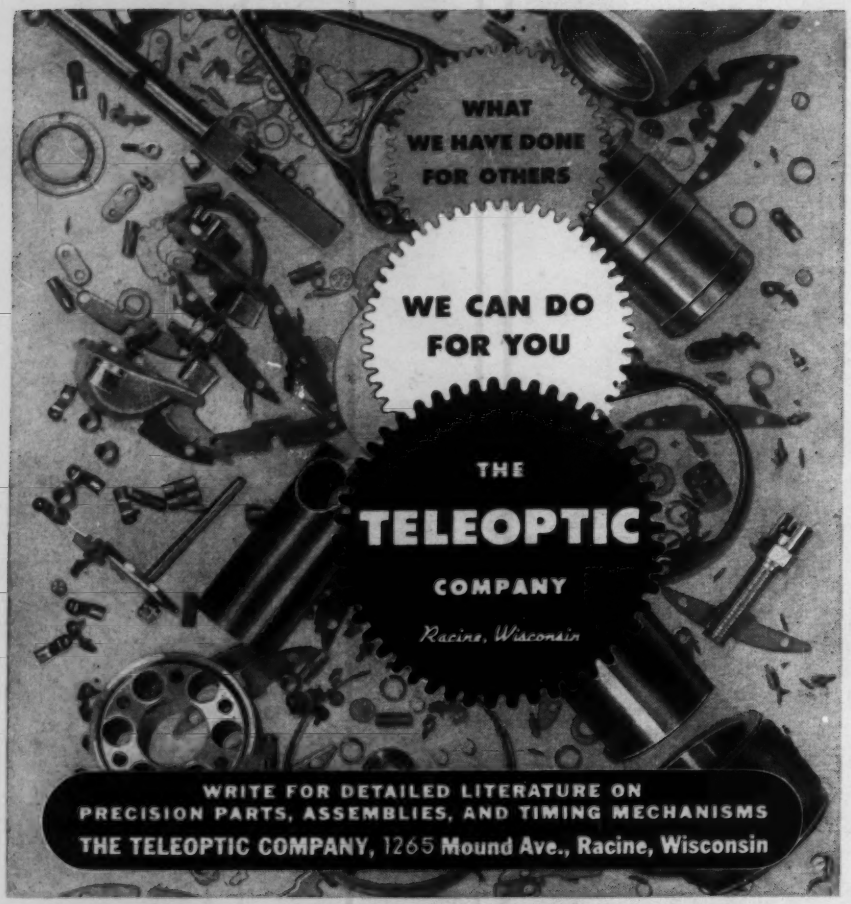

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discharging capacitor through a special gas-filled lamp designed to dissipate most of the energy in about two microseconds, producing an intense, extremely short flash. Flash may be tripped by a make or break contact, by an electrical impulse, or by a microphone which picks up a sound impulse from the phenomenon to be photographed. The microphone is supplied, and an amplifier and gain control are built in. Ordinary film and camera equipment can be used with the "Microflash." Lamp and power supply are mounted in separate metal cases, which lock together in a single unit for transportation. Over-all dimensions (assembled) 24⅛" × 13¼" × 11¾"; net weight 72 lbs.—*General Radio Co., Cambridge 39, Mass.*

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(1) New "Opti-Locator," an optical device for use in centering and measuring problems on all types of machine

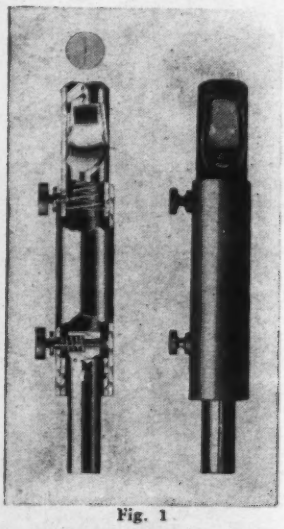

Fig. 1

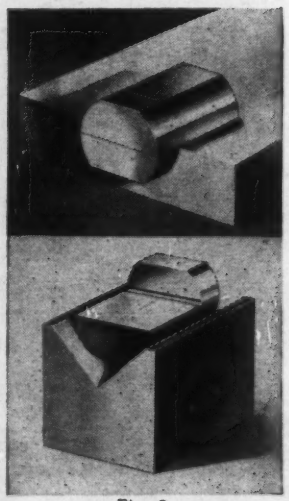

Fig. 2

tools, is 5" long × ⅞" O.D.; is packaged in a 1¼" × 5¼" plastic container. Instrument is removable from the machine for chucking tools without altering machine adjustment and has an accuracy of 0.0001" in visually centering. It is designed and constructed to be used on any machine tool with either

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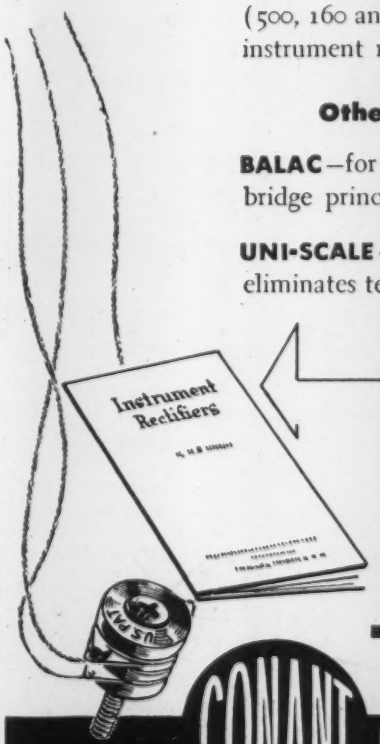

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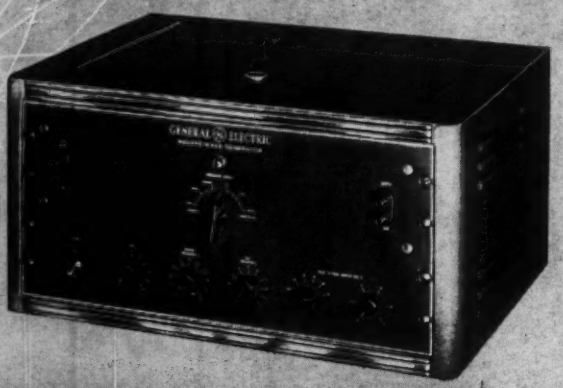

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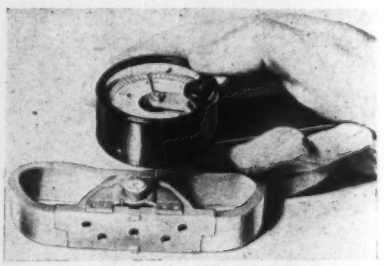
vertical or horizontal spindle and incorporates the following construction features: Standard ½" hardened steel shank for ease of chucking with standard collets, tapers, or other adapters; ⅞" tubular body pivoted to shank by two ball bearings and adjustable laterally by means of a fine threaded "line-up" screw; optical assembly tube can be locked at the desired focal distance. Scribe lines, punch pricks or other marks on work are enlarged by and viewed through lenses clamped by spring pressure to the upper prism faces and the images are refracted through prism and viewed from side at normal distance.

(2) Accessory used to increase utility of "Opti-Locator" is a "Datum Block" providing hairlines by which the optical locator can be aligned to any finished edge. It centers vee blocks and similar fixtures and can be applied with gage block for simplifying inspection problems, as well as determining a zero point for measuring. Block is of hardened and ground tool steel, having cylindrical sides and measuring 1⅜" long and 1" O.D. Three surfaces, all in different planes, are scribed for sighting with "Opti-Locator." One hairline is on top surface in plane of shoulder stop; another on end surface in plane of working surface. These two permit use of device in either horizontal or vertical positions for locating edges. A third hairline, on working surface centrally located between cylindrical sides, accurately splits distance between faces of vee block. — *The Benton Co., 351 South LaBrea Ave., Los Angeles 36, Calif.*

Fluxmeter for Small Gaps

New "Gauss Meter" simplifies measurement of flux of permanent magnets and d-c. electromagnets; is especially useful for checking flux gradients in air



gaps and for determining direction, as well as density, of flux in leakage paths and air gaps. Utilizing a moving-magnet rotor at the end of an exploring prod, this hand-held miniature instrument permits flux to be measured at what amounts to a single point in either the air gap or iron structure. (Later measurement is accomplished by drilling a 0.090" hole in the iron and inserting the prod in this hole to check "H" in the iron.) Extremely small area of sensitivity at end of exploring prod allows instrument to be used in obtaining detailed analysis of flux distribution. Since it does not depend upon voltages induced in a movable search coil, it is somewhat easier to use than the ballistic type fluxmeter and permits more thorough investigation of magnetic structures. "Gauss Meter" is contained in a 2" round Textolite case with a hol-

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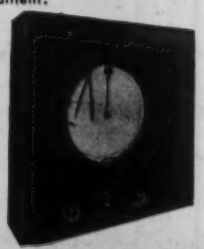
TYPICAL APPLICATION
Bodine Type K Synchronous Spur Gear Speed Reducer Motor used in the Foxboro CycleLog Controller—a deferred action-type of elapsed time-temperature control instrument.

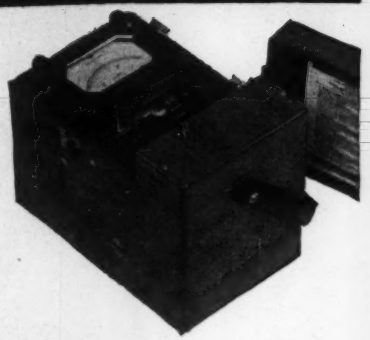


Motor-driven precision instruments require extremely dependable motors. The selection of the correct motor for the instrument is also of great importance.

That is why Bodine fractional horsepower motors are specified by so many instrument makers who require a motor drive. The 40 years of Bodine small motor manufacture has resulted in motors of superior performance—and the availability of Bodine technical aid eliminates guesswork in motor selection. This service is offered to you without obligation. Bodine Electric Co., 2244 W. Ohio St., Chicago 12, Illinois.

BODINE FRACTIONAL HORSEPOWER MOTORS

New... CRANKLESS MODEL C-2 MEGOHMER INSULATION TESTER



Test Potential to 600 Volts DC. Ranges to 1000 megohms with two or three additional ohm ranges in each instrument. Long mirror scales, hand drawn, individually calibrated, with more scale divisions for superior readability and split hair accuracy. Automatically decreasing test potential protects equipment of low resistance value.

Truly a Precision Instrument
WRITE FOR BULLETIN 445

HERMAN H. *Sticht* COMPANY, INC.
27 PARK PLACE NEW YORK N. Y.

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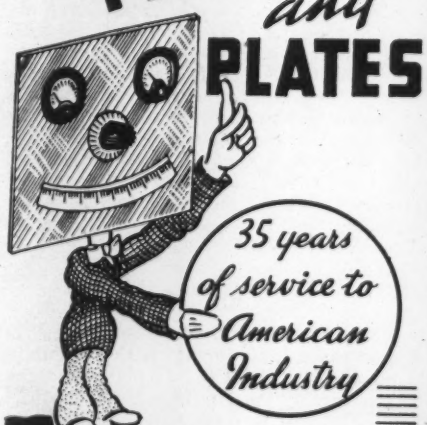

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made to your precise engineering specifications in etched metals and finishes.

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Permanent Magnets FOR LOUD SPEAKERS

From ½ oz. to over 30 lbs. . . . and from start to finish . . . Arnold manufactures better Alnico permanent magnets for loud speakers. They are now available for all civilian applications, and include the proposed Radio Manufacturers Association standard speaker magnets in Alnico V.

The speaker magnets illustrated above are representative, yet are just one type of permanent magnets described in the new 24-page Arnold bulletin, "Permanent Magnets for Industry."

WRITE TODAY *on your company letterhead*
FOR THIS NEW BULLETIN

THE ARNOLD ENGINEERING COMPANY
147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS
Specialists in the manufacture of
ALNICO PERMANENT MAGNETS

Assure *Permanent Accuracy*

● Many safeguards assure accuracy and dependability in Palmer Thermometers. One is illustrated above. The operator is checking size of bore and diameter of tube with a special microscope. Tests like these insure every industry that Palmer Industrial, Laboratory, Dial and Recording Thermometers serve faithfully and well. Their unfailing dependability make them the choice of engineers all over the world.

Only PALMER Gives All Three

1. *Easy "Red - Reading - Mercury" Column*
2. *Extreme accuracy assured by modern testing.*
3. *Long life due to quality workmanship and materials.*

THE PALMER COMPANY

Makers of Industrial, Laboratory, and Recording Thermometers

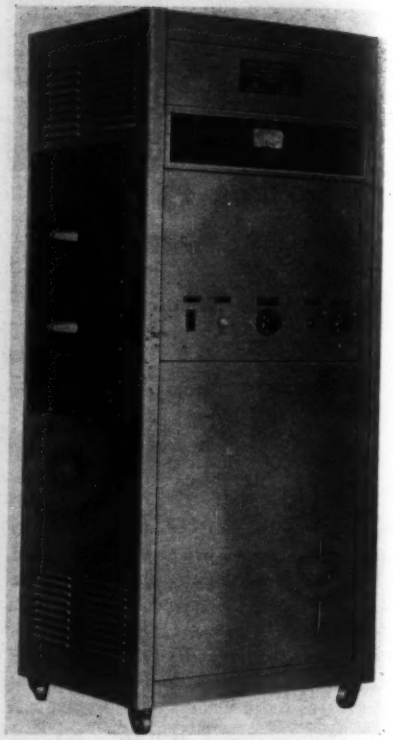
4444 NORWOOD AVENUE CINCINNATI 32, (NORWOOD) OHIO

Canadian Plants: Kingston and Georgetown, Toronto

low bronze exploring prod extending from the back. For instrument work, prods 0.075" diam. and 1¼" long are furnished; for use with larger apparatus, prods 5" long by 0.090" diam. are used. Indication of flux density in gauss is given on a 260° concentric scale; full-scale ranges of 100, 500, 1000, 2500, and 5000 gauss are available. Among industrial applications: Checking flux density and distribution in electric instruments, measuring flux in arc blowout chutes and contactor blowouts, production testing of permanent magnets, and checking electromagnets and relay coils. Educational application: to complement popular iron-filings method of showing flux distribution about a magnet. Since instrument indicates both direction and strength of flux, it gives data needed for plotting lines of equal strength about the magnet, as well as for determining flux pattern.—*Meter & Instrument Div., General Electric Co., Lynn, Mass.*

Insulation Test Set

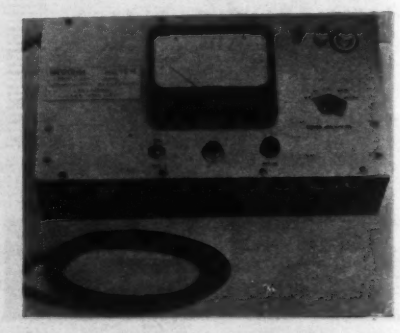
New "Type RD" insulation test set was designed for testing breakdown voltage of materials and components. It has a continuous duty rating of 50 kv. d-c. at 10 milliamperes. It may also deliver up to 50 kilovolts peak, a-c. Output voltages are continuously variable by a "Variac," and are divided into three ranges, 0-10 kv., 0-25 kv., and 0-50 kv. Full 315° rotation of the



"Variac" is employed for each range of output. Output voltage is measured directly in the output circuit with a 4" scale instrument accurate to 2%. Safety features include range-switching interlock, oil-immersed 50 kv. filter capacitor shorting switch interlocked with rear door, electrically-operated power cut-off switch also interlocked with the rear door. A repeating chime gives continuous audible warning that high voltage is being generated and a red indicator light simultaneously gives visual indication. To insure adequate protection for components, current-limiting devices are provided in both a-c. and d-c. circuits, while an adjustable overload relay is provided in output circuit. A main line circuit breaker protects primary circuit. Cabinet is 80" × 30" × 24" deep, gray crackle finish; total weight of 700 lbs. net. Operation is from 115-volt 60-cycle supply; power consumption is 1 kw. — *Radio Development Labs, 362 Atlantic Ave., Brooklyn 2, N. Y.*

Megohm Meter

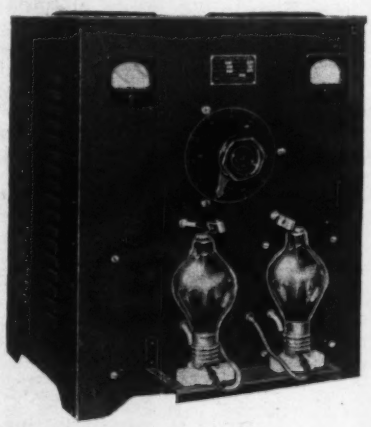
New "Model 1500 Megohm Meter" is a portable instrument with a range from 400,000 ohms to 100,000 megohms in five ranges on single-scale 4" indicator. It is said to have unusual stability



and also exceptional protection against atmospheric conditions where precise testing is required. Accuracy is within 5% at any position on all ranges. Weighing 8 lbs., "Model 1500" may be employed in laboratories or on production lines where it is necessary to measure and test in widely scattered locations. Among applications: measuring leakage resistance of insulation materials, coaxial cables, wiring harness, motor and transformer windings. On production checking of resistors, range may be extended below 400K by the increment method. "Model 1500" is also recommended for determination of moisture content of wood, paper board, plastics, textiles, etc. Data on stability: a change in line voltage from 90 to 130 volts produces a change of less than 3% in reading at mid-scale. Single zero reset adjustment is provided for all ranges and drift after initial warm-up period is claimed to be substantially zero. Efficiently guarded on all ranges to prevent distortion of readings due to atmospheric conditions. Extreme safety measures prevent danger of shock to operator. Accuracy guaranteed better than 5% on all ranges at all points on scale. Line voltage: 115 volts, 60 cycles. Available for immediate delivery without priorities.—*Meter Div., Communication Measurements Laboratory, 120 Greenwich St., New York 6, N. Y.*

Adjustable Voltage Rectifiers

New rectifiers having the d-c. output voltage variable from zero to full voltage can be connected to any specified a-c. power line and deliver direct current which is suitable for nearly all industrial or laboratory applications.



Control of the d-c. voltage is obtained by knob on front panel. Voltage regulation is said to be exceptionally good, owing to the use of adjustable voltage transformers and mercury-vapor rectifier tubes. Tubes are mounted outside main housing to provide proper cooling and freedom from arc-back; and are protected by a perforated metal grille. Rectifiers can be supplied with or without filtering in the direct current. A few suggested applications are: (1) production testing of d-c. motors, electromagnets, etc.; (2) use in electrical repair shops as a universal d-c. supply; (3) universal d-c. supply for laboratory work such as energizing spectrographic, arcs operating variable-speed motors, testing, etc.—*Mellaphone Corp., Rochester 2, N. Y.*

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NON-ABRASIVE
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PERMOPIVOTS
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SUPER-POLISHED
Yes, Extra Value!
Long after the ordinary pivot has worn out you'll find PERMO-PIVOTS in the prime of life—faithfully keeping precision instruments precise! It's all due to the special PERMOMETAL tip—the ideal osmium alloy. . . . Made to your specifications.
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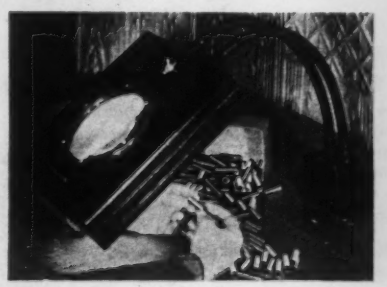
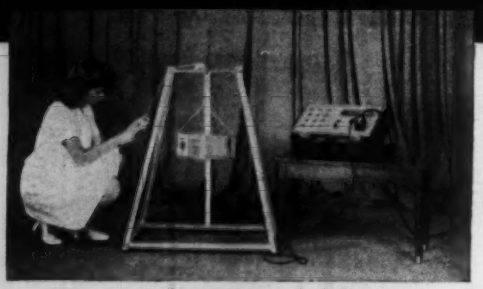
MANUFACTURING METALLURGISTS

Illuminated Magnifier

New "Model 1946" two-tube fluorescent indirect daylighted 5" dia. magnifying lens unit is equipped with plastic under-face protecting lens, reflectors, tubes, etc., from grit, oil and other damaging materials. It can be mounted before machine tools as a guard for operator's face and eyes; can be used for all inspection purposes, either receiving, production or final check, where a good spot light and moderate magnification is needed and where comparators, etc., are either not needed or their expense not justified. It comes equipped with two 6-watt 9" daylight fluorescent tubes, transparent plastic underface, and eight feet of rubber-covered connecting cord, etc., ready to install and use. Starters are in the head, where they can be easily serviced, yet out of harm's way. Snap switch is on top, handy to the operator. A small spirit level, mounted on head just in front of lens, enables operator to adjust lens to same level as inspected work. Ballasts are in a small metal base container, fully sealed in against moisture, etc., by having container completely filled with black insulating compound. Be-



IS YOUR PRODUCT PROTECTED FROM
"SHIPPING SHOCK?"



BE SURE... CHECK YOUR PACKING SYSTEMS WITH THE G-E CUSHIONING METER

ECONOMICAL—without damaging expensive equipment, it provides a simple means of determining the protection against shock afforded by your packing systems.

EASY TO OPERATE—requires no adjustment during measurement. A scientific means of determining whether your product is safeguarded against "shipping shock."

SELF-CONTAINED—in one easily portable case. Operates from any a-c 110-volt, 50/60-cycle outlet.

Also useful for determining the shocks to which equipment is subjected in service. Write for Leaflet GEA-4472. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

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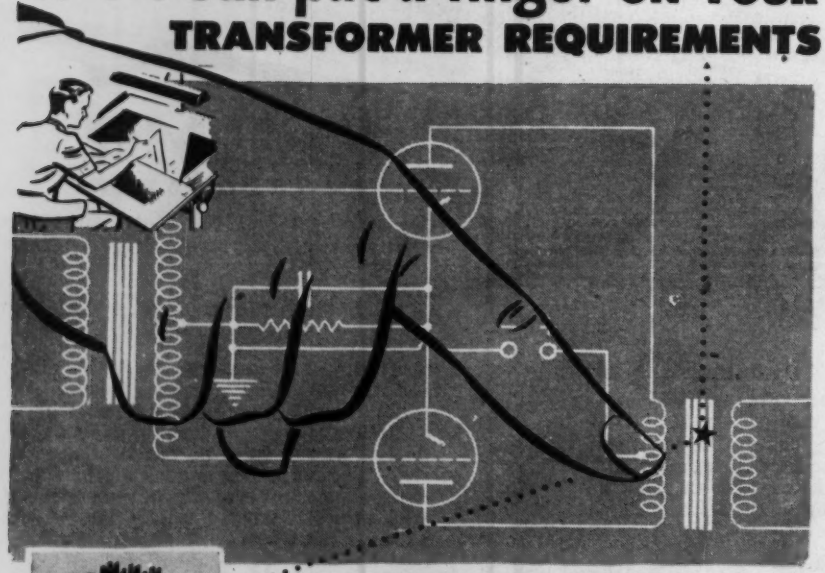

—with emphasis on electrical and mechanical suitability!

The N-Y-T Sample Department has demonstrated its ability to continuously supply advanced transformer, choke and filter designs for most electrical and electronic needs. In every instance, all requirements are fulfilled efficiently, and economically. Let us take care of any samples you may need for new equipment being designed. Address inquiries to Dept. R

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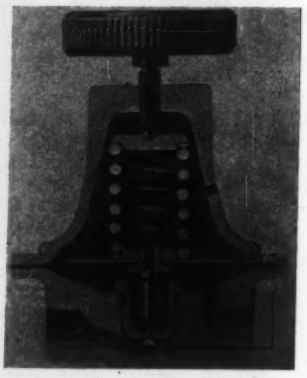
62 WILLIAMS STREET, NEW YORK 5, N. Y.

tween this base and the lens are two flexible arms 16" in length, permitting adjustability in all directions.—*Larrimore Sales Co., P.O. Box, 1234, St. Louis 1, Mo.*

Air Pressure Regulator

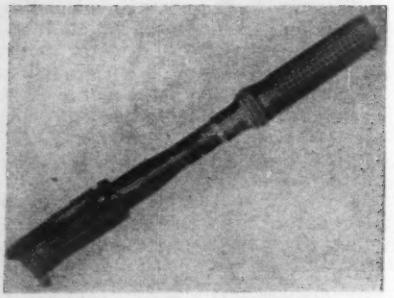
New "H-10" regulator, designed primarily for manual loading service in conjunction with pneumatic industrial



instruments, is said to combine "a high degree of sensitivity with rocklike stability and freedom from 'drift' errors." On dead-end service, new regulator can be adjusted to hold any air pressure from 0 to 25 lbs./in.^{2} constant within 0.05 lb. regardless of vibration or upstream pressure variation. Sensitivity and stability are said to be due to large-area nylon-inserted Neoprene diaphragm and to floating design of plug and seat: no guiding surface where dirt accumulation might become a source of friction. It is suited for mounting inside an instrument case or on a separately mounted panel. Body and spring housing are of forged brass. Plug and seats are highly-polished stainless steel. All other steel parts are cadmium-plated. New regulator is provided with large knurled plastic knob and fine-thread screw requiring six or more turns for full range adjustment. Threaded spring housing and two lock nuts permit flush mounting on any thickness of panel up to 1". Body tappings can be had in either ¼" or ⅛" standard pipe threads. Finish is dull black enamel. Size, 3" diameter × 4¼" overall height.—*Conoflow Corp., 2100 Arch St., Philadelphia 3, Penna.*

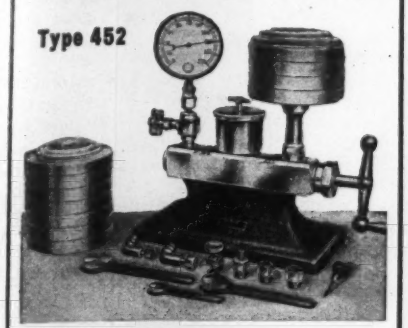
Torque Wrench

New "Model 1600" torque wrench is an extra-large heavy-duty wrench with a torque range from 700 to 1600 in./lbs., and a ½" standard drive. Previous "Model 600" has been changed



AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



Modern design and construction puts this rugged precision instrument in a grade above the ordinary dead-weight testers.

Made in eight ranges, to 3000 lbs. maximum.

We guarantee 1/10 of 1 percent accuracy in each range.

The Type 452 is designed for simplicity and compactness. It incorporates the newest refinements and improvements. Adapters and tools are supplied, as well as either carrying case or protecting cover.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems.

Drop us a line today.

Amthor Testing Instrument Co., Inc.

49a Van Sinderen Ave. Brooklyn, N. Y.

PYRO THE SIMPLIFIED OPTICAL PYROMETER

SAVE TIME AND MONEY!

By using PYRO, a self-contained, DIRECT READING, sturdy unit made to stand rough use. It is absolutely accurate and dependable, and quickly pays for itself.

Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest stream; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" and "Universal TRIPLE RANGE" have, in addition to standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten iron and steel when measured in the open.

Stock ranges 1400° F. to 5000° F.

Bulletins on PYRO Optical, Radiation, Surface and Immersion Pyrometers on request.

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Plant & Lab

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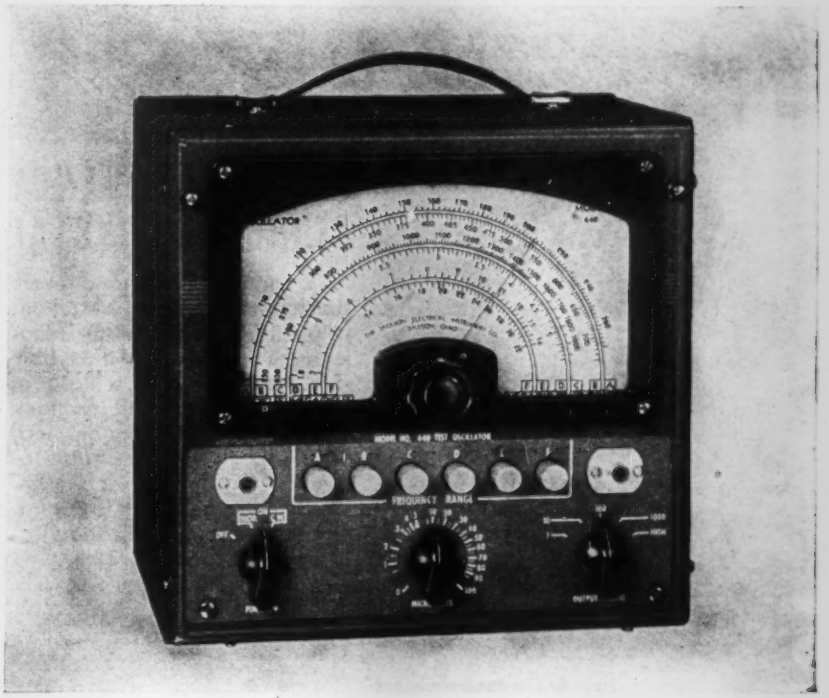


TEST OSCILLATOR
Model 640

A COMPLETE "standard type" oscillator for all general purpose work. Has full range direct reading dial from 100 KC up to 30 megacycles. No skips or harmonics calibrated. All ranges are fundamental frequencies.

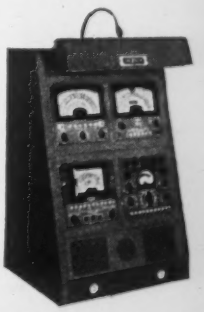
Push Button selection of all ranges makes speedy and accurate operation possible.

Glass Enclosed Dial—prevents dust and avoids possibility of damage to pointer.

Two Circuit Attenuator provides variable ratio and also vernier control.

Has Powerful Signal output which may be used either as pure R.F. or Modulated R.F. The A.F. voltage is available for external use. Carrier is modulated at approximately 30%.

Accuracy Guaranteed to ½ of 1% on all ranges. Operates from 110 volt 60 cycles. Uses three tubes (rectifier, oscillator and modulator).



The Jackson "Service Lab"

Back again, when steel is more plentiful—Jackson Service Labs, assembling in one handy unit your choice of standard sized Jackson instruments! Watch for them.

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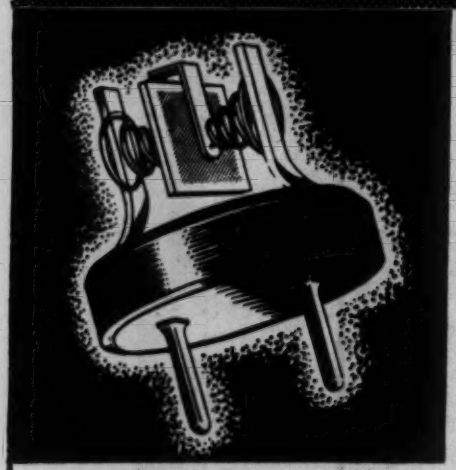
Fine Electrical Testing Instruments

JACKSON ELECTRICAL INSTRUMENT COMPANY, DAYTON, OHIO

Specialists in Special Crystals



100 KC FREQUENCY STANDARD CRYSTAL

. . . Designed to withstand severe shock and vibration. A crystal so precisely finished that it has less than 15 cycles drift from -50C to +85C*. (If oscillator or circuit is furnished, an accuracy of 3-5 cycles can be obtained)

A special solder bead supports a tensile load of 9,000 lbs. per square inch. Crystalab engineered to meet the most rigid operating requirements.

*Also available in frequencies from 80.86 to 200 KC.

Yankee Ingenuity makes us SPECIALISTS IN SPECIAL CRYSTALS

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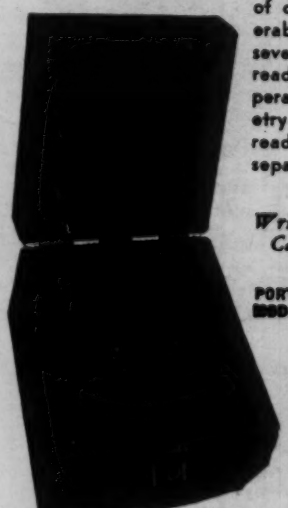
SENSITIVITY RESISTANCE DURABILITY SIMPLICITY

Engelhard Direct Deflection Indicators have all these features . . . Accurate sensitivity to the most minute voltage variations due to suspension type construction . . . High resistance per millivolt and no appreciable error when used with thermocouples of different resistances and on connecting leads of considerable length . . . Sturdy construction, adapted to use under severe conditions without danger . . . So simple that instant readings may be made directly in either millivolts or temperatures by someone unfamiliar with the principles of pyrometry . . . On kilns or furnace installations, where "spot readings" are desirable—the Engelhard Rotary Switch permits separate readings from many points.



Write for Catalog

PORTABLE MODEL P-1

WALL TYPE W-1

CHARLES ENGELHARD, INCORPORATED

90 CHESTNUT ST. NEWARK, NEW JERSEY

to "Model 750" with a torque range of 100 to 750 in./lbs., and a ⅞" standard drive. Both these new models, as well as others, have passed all Army tests, which include accuracy, drop test, oil and water immersion, heat and cold. All moving parts pertaining to torque control feature are now ball-bearing. Variance due to a variable-friction load is said to have been entirely eliminated. Overtightening is impossible: once set, wrench automatically breaks when predetermined torque has been reached. Operator instantly sets torque by turning guide to desired micrometer reading on barrel. Both head and handle are now made of heat-treated aluminum.—*JO Mfg. Co., South Gate, Calif.*

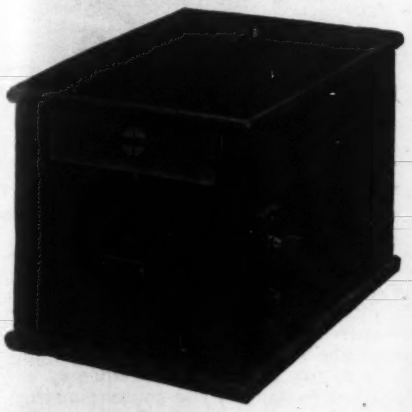
Tungsten Carbide Thread Plug Gages

New series of standard and special tungsten carbide thread plug gages is announced. All popular standard sizes are carried in stock; other standard sizes are available for quick delivery; "extra good service" on semi-standard and special gages. Owing to extreme hardness of tungsten carbide, no wear allowance is necessary.—*The Sheffield Corporation, Dayton 1, Ohio.*

Cold-cathode Point-of-light Tube for Recorders

New "Type R-1130" modulator glow tube of crater type provides high-intensity point-of-light source for recording instrument applications, such as oscillograph timing markers, stroboscopic devices, seismic recorders, photoelectric counters and for facsimile and sound-on-film recording. New tube, usually operated by the single-ended output stage of a push-pull amplifier, provides a modulated point-of-light source by means of a hollow cathode producing high ionization density which may be viewed in depth. Current through the tube varies linearly with the signal voltage regardless of changes in tube impedance. Light output-current characteristics produce good average light response. Bulbs are selected to minimize distortion in the optical path. Useful life is extended through use of mica baffles to reduce bulb blackening. In a typical facsimile receiver, for example, light output of tube is focused through a baffle with a sharp rectangular opening to produce a spot of light 0.0072" high and 0.0104" wide on a drum rotating at 90 r.p.m. Scanning movement is 0.0104" per revolution. "Type R-1130" is supplied in a T-9 bulb with intermediate shell octal base and may be operated in any position. Providing a useful light range between 3500 and 6500 Angstrom units, it will respond to frequencies between 15 and 15,000 c.p.s. Rated at 135 volts d-c. with currents

RUBICON "SPOTLIGHT" GALVANOMETERS



RUBICON MULTIPLE REFLECTION GALVANOMETERS are available with sensitivities as high as 5×10^{-10} amp. or 1×10^{-6} volt per mm. scale division and with periods as short as 1 second. The scales are 100 mm. long and are remarkably proportional.

Hundreds of these sturdy self-contained galvanometers are in daily use in leading educational and industrial establishments for precision measurements by both the null and the deflection methods. Described in Bulletin 320.

RUBICON COMPANY

ELECTRICAL INSTRUMENT MAKERS

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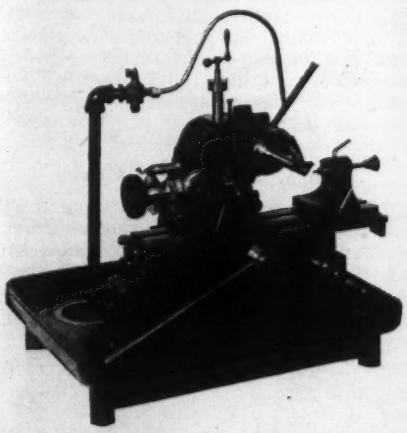
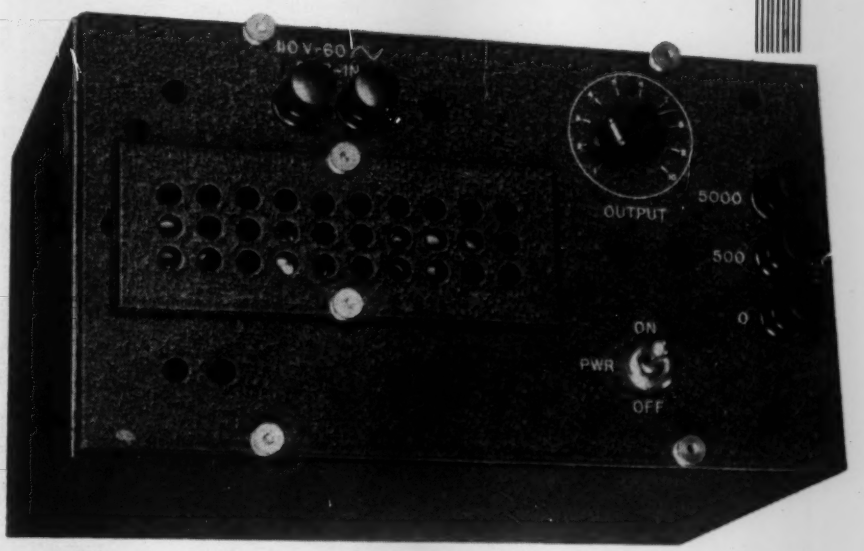


R. P. GALLIEN

220 WEST FIFTH ST., LOS ANGELES 13, CALIF.

Precision Instrument Equipment — Tools and Supplies

Now . . . a compact audio signal source for laboratory and production test applications



The Type MR-1000 is a compact source of audio frequency power producing up to 35 MW of signal energy at output impedances of 500 or 5000 ohms.

The distortion at maximum output is less than 2% over all.

The built-in attenuator features an arbitrary scale of 1 to 10 units.

The Type MR-1000 operates from a standard source of 110 volts, 60 cycles.

The case, panel and subchassis are 1/4" aluminum. A removable ventilator panel at the top permits easy tube replacement.

Using a new type of oscillating amplifier circuit, this unit maintains an output frequency of 1000 cycles at plus or minus 1 cps over 24 hours and will operate continuously for 720 hours with a variation of less than 4 cps.

OPERATION:—The MR-1000 serves to replace tuning forks and offers a source of audio test energy for bridges, etc., and can be substituted in existing test positions without wiring changes. The MR-1000 can be furnished at frequencies other than 1000 cps at slight additional cost.

SIZE:—6¼" deep x 5¾" high x 9¼" long.

WEIGHT:—13½ lbs.

PRICE:—$149.00 f.o.b. Chicago. . . . Guaranteed 2 years.

TELEVISO PRODUCTS CO.

7466 IRVING PARK ROAD CHICAGO 34, ILLINOIS

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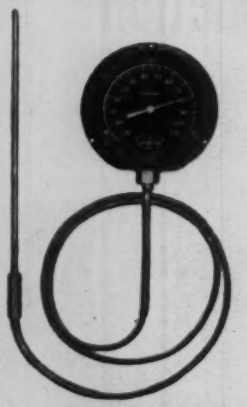

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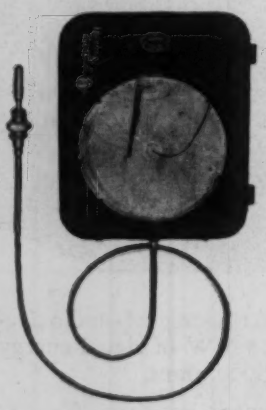

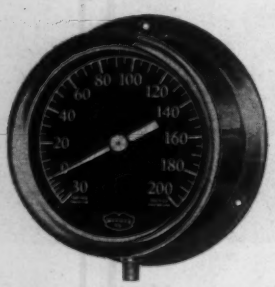

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ranging from 5 to 35 ma., it requires a starting voltage of 170 d-c. maximum. —*Industrial Electronics Div., Sylvania Electric Products Inc., Boston, Mass.*

Remotely-operated Frequency-controlled Switches

New Stevens-Arnold Switches are frequency-controlled tuned relays, suited for remote-control applications with either wire or radio as the carrier medium. In the radio application, switches are sufficiently sensitive so that when made on special order they can be controlled from either a crystal detector or vacuum-tube type receiver. Response time is said to be "a small fraction of a second." Each switch is adjusted at factory to accept a selected band of frequencies in 20-to-800-c.p.s range and to reject all others. In other words, one switch might be controlled by the 50-to-60-cycle band, another by the 65-to-75-cycle band, another by 80-to-95, and so on up. When two or more switches are connected together, combination provides a means of selective switching by a choice of frequency bands. The 20-to-800 range is adequate for control of many separate switches on a single carrier circuit and, by combining the frequency bands in a coded sequence, any number of selective switching operations can be obtained. Frequency selection is obtained by using vibrating-reed principle. Hermetic sealing and other design features

are said to make the switches maintenance-free. Ratings of 1 to 10 amperes, 115-volt a-c., are available. Size shown in illustration is 2-amp. 115-volt and measures 3" × 4" × 5". Seven binding posts are supplied. One set of binding posts is for the selected-frequency a.c. required to control the switch; another set is for auxiliary power to operate the switch; remaining three are the switch terminals, this being a single-pole double-throw model. — *Stevens Arnold Co., 22 Elkins St., South Boston, Mass.*

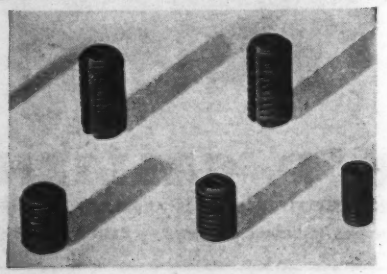
Battery Eliminator

New "A3V Electrox" battery eliminator is said to have widespread commercial and industrial applications.

Connected with 110-volt 60-cycle lighting circuit, it delivers a smooth, noiseless d-c. output of 3 volts, 150 milliamperes. Unit is small: transformer, choke, capacitor and rectifier being enclosed in a metal can housing 3" high × 2½" diam. Experience has shown that the copper-oxide rectifier, properly used, will last indefinitely.—*Electrox Div., Schauer Machine Co., 2055A Reading Rd., Cincinnati, 2, Ohio.*

Screw Type Iron Cores

New screw type molded iron cores are said to offer many engineering and constructional advantages by their being threaded: (1) No brass core screw is necessary for their adjustment; (2)



there is no metal in field of coil; (3) cores themselves are not grounded; considerably higher Q results; (4) smaller assemblies are readily possible because overall length of coil and screw type core is less than that of conventional core, machine screw and bushing; (5) smaller cans can be used; (6) threaded coil forms are unnecessary in many cases: instead, "C" clips extending through slots in coil forms can be used to contact core threads; (7) design of i-f. and dual i-f. transformers for AM and FM is greatly facilitated because screw cores may be tuned from one end of transformer can by placing coils side by side; (8) antenna, r-f. and oscillator coils for each band of multi-band sets become small and compact by use of screw cores and may be mounted in groups for each band.—*Stackpole Carbon Co., St. Marys, Penna.*

UHF Triode

New "TUF-20" triode developed especially for the ultra-high frequency field features "Nonex" glass and a tantalum plate, will operate at full ratings up to 250 Mc. and at reduced ratings for higher frequencies. It is designed primarily for mobile application, for which its internal structure has been engineered. Instant-lighting thoriated filament permits power conservation during stand-by periods yet can be brought quickly up to maximum operating temperature whenever desired. Tube characteristics: Size, 3¾" overall height by 1½" max. diam; Micalex octal base, with grid and plate connections brought out through top of tube; Grid to plate capacitance, 3.6 mmfd; Grid to filament capacitance, 1.8 mmfd; plate to filament capacitance, 0.095 mmfd; Amplification factor, 10; Filament 6.3 volts a.c. or d.c. at 2.75 amps; Maximum plate power, 750 volts at 0.075 amps; Plate dissipation, 20 watts. Typical operation: Plate volts, 750; Plate current, 75 milliamperes; Grid voltage, minus 150 volts; Maximum d-c. grid current, 20 milliamperes; Approximate driving power, 1.5 to 2.5 watts; Approximate carrier output, 40 watts (at 115 Mc.). —*Taylor Tubes, Inc., 2312 Wabansia Avenue, Chicago, Illinois.*

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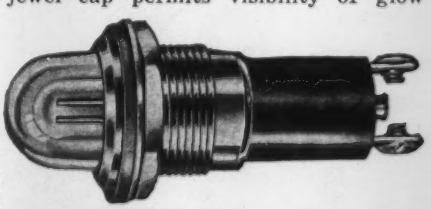
Pilot Light Assemblies

New "Series PL-849" pilot light assemblies feature a built-in resistor (patent pending) as an integral element of the assembly. Resistor enables direct connection to 115-volt circuits. Ratings for the resistor are available as follows: 100,000 ohms for bright glow; 200,000 for dimmer glow; 270,000 ohms for 220-volt circuits. New method eliminates possibility of short circuits occurring through accidental contact, since resistor is completely enclosed; contact spring and resistor are one sub-assembly within the unit. Units are approx. 2-3/16" × 11/16" over-all. Housing is of molded Bakelite; plastic jewel cap permits visibility of glow from all angles. Where space in front of panel permits, a longer jewel cap is available, giving added illumination. Jewel cap may be had in a choice of seven colors. Units are made to house neon NE-51 bulbs giving penetrating glow, consuming less current, and providing longer life. Radio panel bulbs such 47, 44, etc., may also be used. All bulbs are removable from front of panel. Terminals are especially rugged; cannot turn and will not short. Screw type or soldering type terminals may be had.—*Dial Light Co. of America, Inc., 900 Broadway, New York 3, N. Y.*



Interval Timer

New automatic timer provides a range from 1 to 120 seconds in increments of one second. Timing accuracy is better than 5%. Unit is housed in slope-front steel cabinet with crackle finish. Two dials are provided for time selection: one calibrated in single sec-

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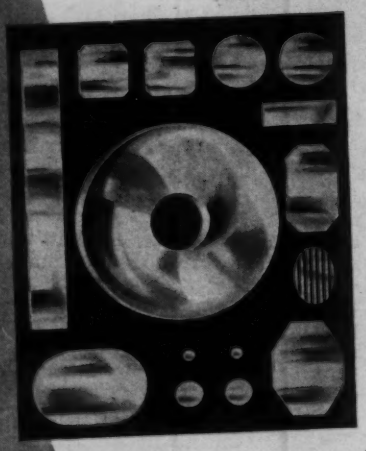

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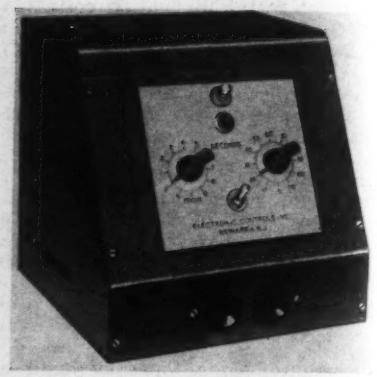


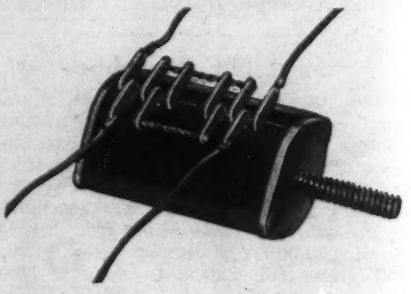
onds; the other in 10-second steps. Dials control tap switches. These snap-positioning step-switches assure reproducible control, with exact values of resistance inserted in circuit at each position. A pilot light, toggle on-off switch and push-switch, are included. A double receptacle permits timing two circuits simultaneously. Contacts are normally wired s-p.d-t. with double break and are rated at 25-amp 32-volt d.c., 25 amp. 125-volt a-c. and 10-amp. 230-volt a.c. Contacts can be wired d-p.d-t. at correspondingly lower rating. Cabinet size is 8″ × 8″ × 8″. Tube used is a 2050 thyratron. High-accuracy resistors are said to assure precise timing. Timing is independent of time the tripping push button is depressed. Dial switch is provided with a position for continuous circuit closure. —*Electronic Controls, Inc., 44 Summer Avenue, Newark 4, New Jersey.*

Thermocouple Tubes

New cast-iron thermocouple protecting tubes are said to meet advanced requirements of chemical, metallurgical and die-casting industries. Their wall thickness is uniform within ±1/32″ and surface finishes are better than those of previous models. Tubes are cast with both ends open, permitting positive support for core at each end. One end is closed with a cast iron plug, welded in place with a cast iron filler rod, the opposite end being threaded for a 1″ standard pipe. Inside diameter is 13/16″; O.D. 1⅜″; wall thickness 9/32″; minimum top thickness 9/32″; weight 4.5 lbs.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Pa.*

Double-unit Full-wave CuO Rectifier

New full-wave copper oxide rectifier, rated at either 12 volts a.c. and 50 milliamperes d.c., or 6 volts a.c. and 100 milliamperes d.c. has been added to



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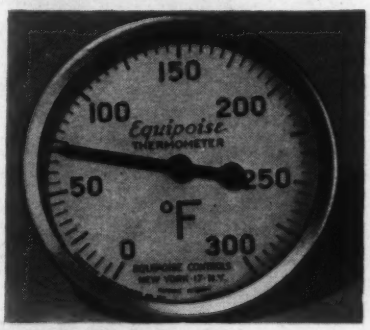

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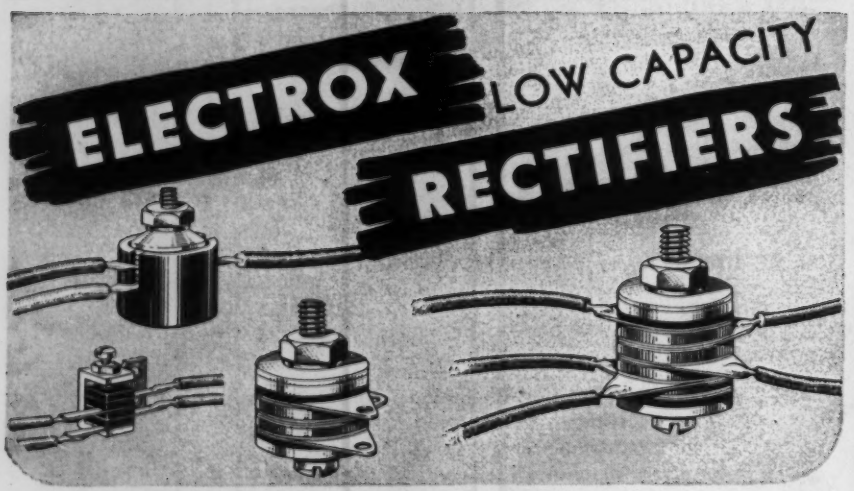

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ELECTROX DIVISION

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line of "Coprox" rectifiers. It is actually a double unit of maker's "Model CX-4D4-F23" redesigned to handle much greater capacity than original version. Single unit is now rated at 6 volts a-c. and 50 milliamperes d-c. continuous. It mounts on a single screw, is fully enclosed and completely sealed with a special plastic compound. Presoldered lead wires prevent overheating during assembly.— *Bradley Laboratories, Inc., 82 Meadow Street, New Haven 10, Conn.*

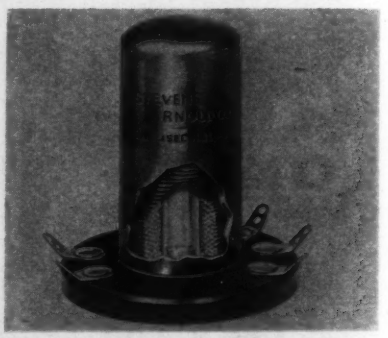
One-watt Resistor With Axial Leads

New "Akra-Ohm Type 188" fixed wire-wound resistor is said to meet the need for a small, close-tolerance unit

rated at 1 watt with maximum resistance of 1 megohm and having axial leads for mounting by leads on standard terminal strips. Unit is 1-3/16" long × ⅜" diameter. Axial leads, 3" long, of #20 tinned copper wire, permit use of resistors in original equipment or as replacements. Standard tolerance ±1%; up to ±0.1% on special order. New unit supplements previous axial-lead "Type 181-A" rated at 0.3 watt and having a maximum resistance of 150,000 ohms.—*Shallcross Mfg. Co., Jackson & Pusey Avenues, Collingdale, Penna.*

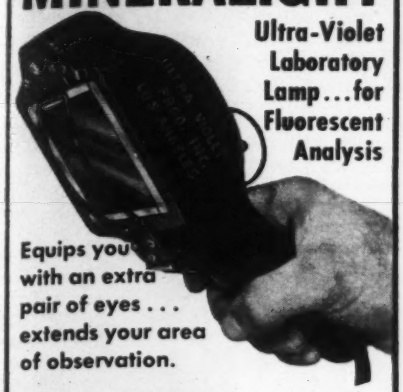
Ultra-high-speed Relay

New "Millisec Relay" is a hermetically-sealed sensitive relay capable of speeds up to 1000 operations per sec-



ond by reason of new basic design of moving elements. In illustration, cutaway reveals glass envelope which surrounds all moving parts and protects them from moisture, dust or corrosive fumes. This new type of construction, is said to make sensitivities down to 0.5 milliwatt possible. Ratings up to 5 amperes can be obtained. Closing time can be less than one millisecond. Outside dimensions of the 115-volt a-c. 1-ampere rating are 3" high and 1½" base diameter. — *Stevens-Arnold Co., Inc., 22 Elkins St., South Boston, Mass.*

MINERALIGHT



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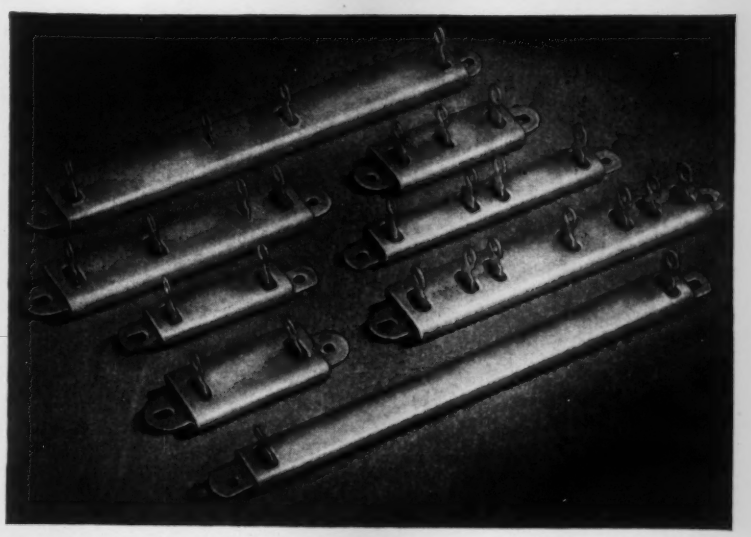

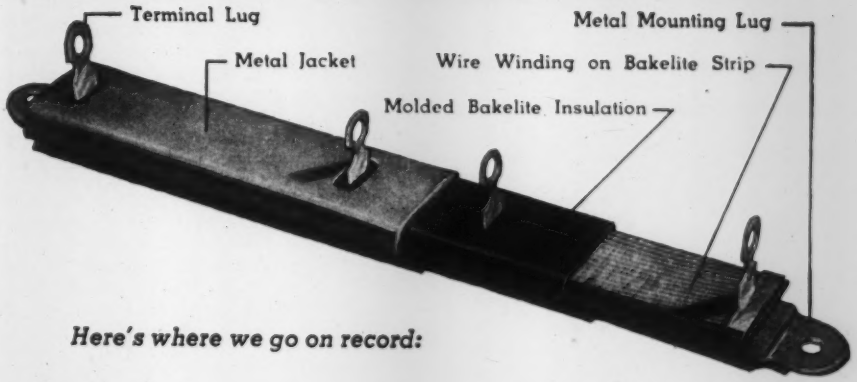

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Instrument Societies

CHICAGO

The scheduled speaker, Dr. H. B. Hawkins, Vibration Engineer, of Bell Aircraft, was unable to attend the regular meeting of the Chicago Section of The Instrument Society of America, held December 3rd, because of transportation difficulties. In his place the Society was fortunate in being able to have Howard C. Roberts of the Association of American Railroads cover practically the same subject. His remarks were directed toward the instrumentation problems involved in railroad research work.

Four reels of movies, made by the Association, were shown at the meeting, and during the running of the film Mr. Roberts explained the uses of the various types of instruments shown. He indicated that careful consideration must be given the type of equipment used, and that its selection was not entirely a matter of choice and convenience for the particular job involved.

The ensuing discussion period covered railroad progress in the research instrumentation field. The application of instruments for other test purposes was also brought out.

Mr. Roberts was kind enough to bring over several reprints of his articles relative electric gaging methods, their selection and use. These were passed among the members.

The Society extends its most hearty thanks to Mr. Roberts for his cooperation in the presentation of his paper.

—D. E. HAINES, *Program Chairman*

GULF COAST

The Instrument Society of America, Gulf Coast Section, held their December meeting at the Jefferson County Health Clinic Wednesday evening, December 19, at 7:30 p. m. Thirty-two members and visitors attended.

R. L. Nichols, Program and Publicity Chairman, presented a brief outline of the objectives of the Association. This was followed by a lengthy and spirited discussion relative possible benefits, activities, etc.

The report of the Nominating Committee was received and acted upon. The following officers were elected to serve through 1946: *Chairman:* T. H. Pierson (Goodrich Rubber Co.); *Vice-Chairman:* G. B. Fulbright (Magnolia Petroleum Co.); *Secretary-Treasurer:* O. G. Sanders (Neches Butane Co.); *Program and Publicity Chairman:* R. L. Nichols (Magnolia Petroleum Co.)

A meeting of the new officers will be held the first week in January, to plan the activities for 1946. Several excellent lectures are in prospect.

The meeting adjourned at 10 p. m.

—MEMBER

INDIANAPOLIS

Another organizational meeting of the group from Indianapolis was held December 6, 1945, at the Purdue Extension Center, 902 N. Meridian Street, at which time the temporary steering committee (Sisson, Fox, Keeler, Rockwell and Underwood) was empowered to act for the society until regular officers were elected.

At the conclusion of the business meeting, which was both very satisfactory and well attended, a war training film made by the Disney Studios for the Minneapolis-Honeywell Company on "The Automatic Pilot" was shown and enjoyed by the entire group.

—MORRIS UNDERWOOD,
Temporary Secretary-Treasurer

I.S.A. Sections which have ratified the Constitution

Section	*Date*
1. Pittsburgh	Oct. 22
2. Charleston	Nov. 12
3. Philadelphia	Dec. 12
4. Washington	Dec. 12
5. St. Louis	Dec. 18
6. Tennessee	Dec. 19
7. New York	Dec. 19

NEW JERSEY

The regular monthly meeting of the New Jersey Section of The Instrument Society of America was held December 4th, 1945 in the Essex House. M. H. White, the previously-announced speaker, was unable to attend (due to illness), but we were fortunate in having in our own group one who could "pinch-hit" on short notice: Harry Moore of Esso Development Lab discussed "Automatic Control in Continuous Processes." He drew from his wide experience in the oil refinery industry to show where each type of control found its application in. a continuous process. He brought out the five basic forms of control in the course of the lecture and discussed the relative phases of each.

At the conclusion of his presentation, which was over at an early hour, an interesting discussion period followed and numerous questions asked, which were referred by Mr. Moore to his Standard Oil acquaintances, for answers.

Considerable time was given to discussions pertaining to both local and National affairs with regards to the I.S.A. and many questions were asked. President Roberts undertook to answer each.

—H. S. CLOSE, *Secretary*

NEW YORK

Thirty-two members and guests of the New York Section of the Instrument Society of America gathered at the Men's Faculty Club, Columbia University for the 35th regular meeting held on Dec. 19. Professor Kayan, our President, called our attention to the constitution of the Instrument Society of America, that had been sent to all members in November. After some discussion, the membership present unanimously ratified the constitution.

The report of the Nominating Committee was presented. The names of those proposed by the committee for officers will be acted upon at the regular meeting on January 28, 1946, at which time the election will be held.

At the conclusion of the business session, Donald P. Eckman, Brown Instrument Company, gave an illustrated lecture on "Type of Automatic Control Actions."

—H. L. HILDENBRAND, *Secretary*

PHILADELPHIA

[Rec'd Dec. 11 by Instruments, too late for Dec. issue]

At the October 17 meeting of the Philadelphia Section of the Instrument Society of America, Lyman H. Allen, Jr., of American Viscose Company, presented a very interesting talk on "Fractionating Column Control."

Before going into details into some of the control problems involved, he discussed some of the fundamentals considered in the design of fractionating columns; also gave a short history on the evolution of distillation systems. A better appreciation of reasons for various applications of controls and their relationship to each other was thereby created.

The second part of Mr. Allen's talk covered the control aspects. He outlined some unique control methods that created spirited discussions after the formal portion of the presentation.

After the meeting the Philadelphia Section served soft drinks, pretzels, and other refreshments.

—MEMBER

PHILADELPHIA

At the meeting of the Philadelphia Section of the Instrument Society of America, held December 12, the following officers were elected to serve for the coming year: *President:* Jack Johnston (Sun Oil Company); *Vice-President:* Fred H. Trapnell (E. I. duPont de Nemours & Company); *Secretary:* Clarence W. Wood (Mason-Neilan Regulator Company); and *Treasurer:* John C. Whiddett (Automatic Temperature Control Company).

The meeting was primarily devoted to business affairs. The ultimate desire was to start the new year off on the right foot; and the determination to be a definite asset to each individual member as well as to the I. S. A. was the evident objective. Our letterhead will be re-designed to show the Society name as Instrument Society of America — Philadelphia Section. An employment committee was selected to carry out the most important task of assisting society members and discharged service men in getting employment.

—GEORGE E. GRESS, *Secretary*

PITTSBURGH

At the December dinner-meeting of the Pittsburgh Section of the Instrument Society of America, held at the Roosevelt Hotel, December 17, L. E.

Eige, Assistant Sales Manager of the Fisher Governor Company, discussed "Diaphragm-motor Valves and Components." He concentrated on the parts of diaphram-motor valves that are usually merely accepted without much thought or explanation—the bodies and plungers. He approached his subject from an engineering standpoint and incorporated the problems encountered in the making of castings, "For instance, the high tensile iron parts used in castings for valves cannot be produced in the same manner that structural shapes in iron, or such pieces as found in farm implement machinery, man-hole covers, etc.," was an example used by the speaker, which conveys the trend of his presentation.

Numerous slides were shown to indicate the various topics of interest and to show the methods used to detect defects that often are present in valves, which are revealed when carefully examined with x-rays or by the magnifluxing operation.

The speaker succeeded in impressing upon us that there is more to a valve than is commonly known. A better sense of appreciation of this phase of instrumentation was instilled in our minds and will serve to add to the pleasure of working on and with them, in the future—to say the least.

—R. H. KNAPPER,
Chairman Meetings Committee

ST. LOUIS

The St. Louis Section of the Instrument Society of America held the December meeting at the York Hotel in St. Louis on December 18, at which time the membership unanimously ratified the National Constitution of the I.S.A., as approved at the national meeting held in Pittsburgh, October 19 and 20. Ralph Munch, the St. Louis representative at that national meeting, presented his report on the constitution and recommended ratification, which was, as indicated, heartily approved by both members and officers.

The speaker, H. S. Fairchild of E. B. Badger & Sons, Boston, Mass., spoke on "Impressions of a Late Comer to the Field of Instrumentation." He related the circumstances of his entry into the field of instrumentation — by way of the Brown Instrument Company School at Philadelphia, with subsequent employment by the Standard Oil Company at Aruba, Netherlands West Indies, and Sun Oil Company at their Marcus Hook refinery and finally with Badger & Sons. He emphasized the variety of process and control problems faced by the Instrument Engineer and the close intimacy each have with the operations of the plant and processes. Fairchild pointed out that in many cases, as a result of this close relationship with process and control, the instrument man often knows more about certain process or plant operation than anyone else in the plant, with the possible exception of the superintendent. In the past, he asserted, the Instrument Man's job has many times been a dead-end job, but this is, however, becoming less true, as this familiarity he has with the plant operations is becoming more and more recognized.

The speaker recommended that all those interested in Instrumentation, and

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INSTRUMENT SOCIETIES CALENDAR

City	Society and Secretary	Date	Place	Subject	Speaker
Atlanta, Georgia	Georgia Society for Measurement & Control — Robert E. Geminert, P.O. Box 1714, Atlanta		Blue Flame Room, Atlanta Gas Light Co.		
Baltimore, Maryland	Baltimore Industrial Instrumentation Society — F. Ragan, Fuel Div., Beth Steel, Sparrows Pt., Md.		Engineers Club, 6 W. Fayette St., Balto.		
Charleston, W. Va.	Charleston Section, I. S. A. — M. B. Lorig, 1506 Virginia St., Charleston 1	Feb. 4(B)	Ruffner Hotel	Telemetering	P. A. Borden, Bristol Co.
		Mar. 4(B)		Boiler Control	M. J. Boho, Hagan Corp.
		Apr. 1(B)		Control Valves	Bruce A. Irwin, Mason-Neilan Co.
		May 6(B)		Pneumatic Transmission and Control	W. B. Heinze, Cochrane Corp.
Chicago, Ill.	Chicago Section, I. S. A. — A. J. Butler, c/o IHC, 2626 W. 31st Blvd., Chicago	Feb. 4(B)	(To be announced)	Instrumentation in Plant Design	(To be announced)
		Mar. 4(B)	(To be announced)	Application of Valves in Automatic Control	C. E. Mason, Bristol Co.
		Apr. 1(B)	(To be announced)	New Optical Tools	J. W. Forrest, Bausch & Lomb
		May 6(B)	(To be announced)	New Electronic Measuring Instruments	W. Mikelson, General Electric
Cleveland, Ohio	Cleveland Instrumentation Society — A. J. McCullough, Minneapolis-Honeywell, 5005 Euclid Ave., Cleveland 3	Jan. 23(B)	Cleveland Engineering Society, E. 19th St. off Prospect Ave.	Dynamic Measurements of Strain, Pressure, Torque, etc.	D. O. Komich Trimount Instrument Co.
		Feb. 27(B)	Cleveland Eng'g Soc.	Pneumatic Null Balance	C. B. Moore, Moore Products Co.
Detroit, Mich.	Instrument Society of Detroit — Cliff Sackett, Chrysler Eng'g 12800 Oakland Ave. Det't				
Florence, Alabama	Muscle Shoals Instrument Society — J. W. Moffett, 323 E. Mobile St., Florence				
Fort Worth, Texas	Fort Worth Electronics Club — Ralph Ely, 1116 E. Arlington, Fort Worth		Texas Hotel, Fort Worth		
Gulf Coast (Texas)	Gulf Coast Section, I. S. A. — C. D. Hok, 2509 Lake Shore Dr., Port Arthur, Texas				
Hartford, Conn.	Hartford Society for Measurement & Control — Gustave L. Manke, c/o Veeder-Root, Sargent & Garden Sts.	Jan. 22(B)	Bond Hotel	Practical Inspection of Metals	Dave Nemser, International Nickel Co.
		Feb. 19(D)	Bond Hotel	Use of Air in Gaging	R. Y. Moss, Sheffield Corp.
		Mar. 19(B)	Bond Hotel	Electron Microscope	Dr. R. B. Barnes, C. J. Burton, Amer. Cyanamid
		Apr. 16(B)	Bond Hotel	Comparison of Materials for Gages	H. O. Richter, W. R. Moore, Norton Co.
		May 21(B)	Bond Hotel	(Annual Business Meeting)	
Indianapolis, Ind.	Indianapolis Section, I.S.A. — Morris Underwood, Temp. Sec.-Treasurer	Feb. 5		(To be announced)	
		Mar. 5		(To be announced)	
Kansas City, Missouri	KC Industrial Instrumentation Society — Gordon H. Burke, 1527 Broadway, Kansas City, Mo.	Jan. 29(B)	Blue Bird Caf.	Hydraulic Automatic Airplane Pilots (Also Film)	Myron M. Clark T.W.A.
Los Angeles, Calif.	California Instrument Society — M. D. Pugh, 541 South Spring St., Los Angeles, Calif.		Melody Lane, Los Angeles		
Newark, N. J.	Society for Measurement & Control (New Jersey) — H. S. Close, 831 Dixie Lane, Plainfield, N. J.	Feb. 5(B)	Essex House	Forum Night Questions and Answers	H. F. Moore, Technical Chairman, Moore Products
		March 5(B)	Essex House	Combustion Control	Harry R. Kessler, Republic Flow Meter Co.
New Orleans, La.	New Orleans Instrument Society. — W. H. Haney, 1016 Esplanade Ave., New Orleans, La.		St. Charles Hotel	(To be announced)	
New York, N. Y.	New York Society for Measurement & Control — H. L. Hildenbrand, 206-07 33d Ave., Bayside, L.I., N.Y.	Jan. 28(B)	Faculty Club 400 W. 117th St.	Automatic Control—Motors	R. B. Darling, Barber-Colman Co.
		Feb. 25(B)		Automatic Control—Servomechanisms	L. A. MacColl, Bell Telephone Labs., Inc.
N. Indiana	Northern Indiana Section, I. S. A. — C. P. Haynes, Red River Oil Refinery, 935 — 177th Place, Hammond, Ind.	Jan. 18(B)	Lake Hotel, 740 Washington St., Gary	Application of Hydraulic Control	D. Pray, Askania Regulator Co.
Philadelphia, Pa.	Philadelphia Section, I.S.A. — Clarence W. Wood, Mason-Neilan, 6908 Market St., Upper Darby, Pa.		Broadwood Hotel, Broad & Wood Sts.		
Pittsburgh, Pa.	Pittsburgh Section, I.S.A. — L. M. Sussny, c/o Carnegie Institute, 4400 Forbes St.	Jan. 28(B)	Roosevelt Hotel	Captured Gyro Inst's	Walter T. Buhl, Jack & Heintz
		Feb. 25(B)	Roosevelt Hotel	Fractionating Column Control	Lyman H. Allen, Jr. Amer. Viscose Corp.
		Mar. 25(B)	Roosevelt Hotel	Inst. Maintenance in Oil Refinery	M. H. White, Atlantic Ref. Co.
		Apr. 22(B)	Roosevelt Hotel	Control Valve Characteristics	R. Rockwell, Mason-Neilan Co.
		May 27(B)	Roosevelt Hotel	Fractional H.p. Electric Motors	C. G. Veinott, Westinghouse Elec. Co.
St. Louis, Mo.	St. Louis Society for Instrumentation — Gus Holubeck, Union Electric Co., Venice, Ill.	Jan. 28(C)	York Hotel	Fractionating Column Control	David M. Boyd, Jr.
Sarnia, Ont. Canada	Sarnia Instrument Association — K. Williamson, 168 Cobden St., Sarnia, Ont., Can.				
Southwest Texas	South Texas Instrument Society — Homer C. Givens, La Gloria Corp., Falfurrias, Tex.				
Kingsport, Tenn.	Tennessee Section, I. S. A. — C. F. Palmer, 2924 J. C. Hwy., Kingsport	Feb. 13(B)	Kingsport Inn	pH Instruments	J.F. Sneath, Leeds & Northrup
Toronto, Canada	Ontario Section, I.S.A. — T. C. Agnew, Minneapolis-Honeywell Reg. Co.		Chez Paree Restaurant, 220 Bloor St., W.		
Washington, D. C.	Washington Section, I.S.A.	Jan. 22(B)		(To be announced)	
Whiting, Indiana	Whiting Instrument Men's Guild — Lloyd Clouse, 7344 Dante Ave., Chicago 19, Illinois				
Wyandotte, Mich.	Instrument Society of Wayne County — Charles Chessroom, P. O. Box 150, Wyandotte, Mich.		Presbyterian Church Hall, 1st and Chestnut Sts.		

(A) Meeting at 7:30, no dinner — (B) Dinner at 6:30, meeting at 8 — (C) Dinner at 7, meeting at 8 — (D) Meeting at 8, no dinner

in advancing in this field, take specialized courses of study along those lines, preferably taught by men in the plants who can bring the subject down to earth and every-day application.

The enthusiasm and imagination that was incorporated in his presentation created considerable interest, as the flood of questions and remarks at the conclusion of his presentation indicated.

—H. E. ZEFFREN, *Secretary*

WASHINGTON

At the December meeting of the Washington Section of The Instrument Society of America, held in the Interior Department Auditorium, on December 12, results of the election of officers were announced. The elected officers are: *President:* R. C. Darnell; *Vice Presidents:* D. F. Widenburg and W. G. Brombacher; *Corresponding Secretary:* G. M. Rolls; *Recording Secretary:* R. G. Quick; *Treasurer:* Raymond Morgan; *Councilors:* A. H. Mears and G. H. Lovins; *Delegate to National I.S.A.:* W. A. Wildhack.

We are happy to announce that our Society voted to affiliate with the National Society and will, therefore, be known as "Washington Section of The Instrument Society of America."

After the business session, Lester E. Demler of Wallace and Tiernan Products Company gave a lecture on "Custom Calibrated Aneroid Instruments." At the conclusion of his illustrated address, the members and guests took active part in the discussions and the examination of various instruments displayed by the speaker.

—G. M. ROLLS, *Corresponding Sec'y*

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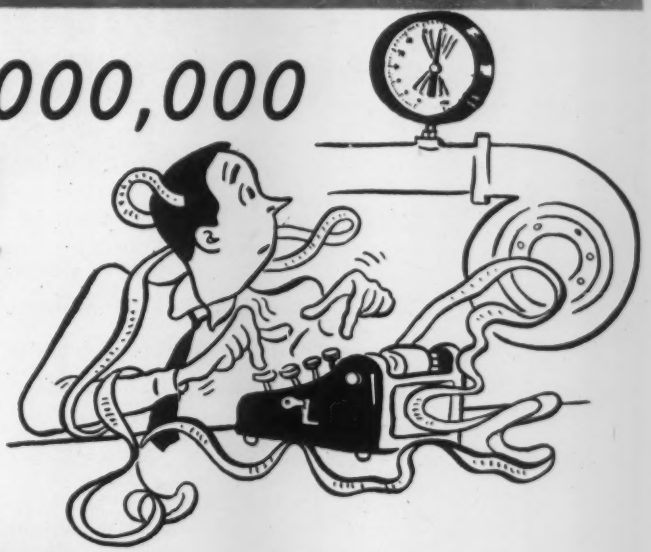

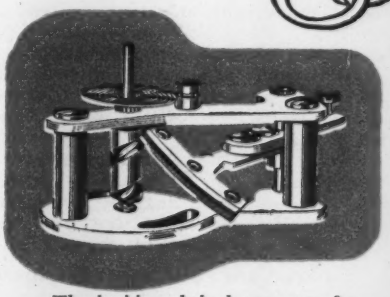

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card inside the back cover.

N-1 **Illuminated Magnifier.** 4-page 8½″ × 11″ Catalog H-10 pictures and describes various battery and plug-in models of "Flash-O-Lens" illuminated magnifiers that make possible accurate inspections in a hurry. E. W. Pike & Co., Mfrs., P. O. Box 4, Elizabeth 3, N. J.

N-2 **Temperature Control Switch.** 2-page 8½″ × 11″ bulletin (identified as Vol. 1, No. 1) describes and illustrates a thermostat using snap-action switches. Included is a sketch showing a wafer type heat-sensitive element partly filled with a vaporizing liquid that operates the switch when the temperature varies. The operation of this dual contact switch is also shown in three schematic diagrams. Micro Switch Division, First Industrial Corporation, Freeport, Ill.

N-3 **Code Card and Chart for Capacitors.** Color code card and chart which gives the RMA standards for the six-dot color code and the three-dot color code, as well as the Army and Navy Standards, is handy to users in identifying small mica capacitors. Cornell-Dubilier Electric Corp., New Bedford, Mass.

N-4 **Commemorating the 50th Anniversary of X-ray.** 8-page 5¼″ × 7¼″ booklet has on its cover a reproduction of the calendar design prepared by this company to commemorate the 50th Anniversary of the discovery of x-ray by Roentgen. The story of x-ray from 1895 to 1945 and the role played by the company in this important field of science are given. North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.

N-5 **Five-range Tachometer.** 4-page 8½″ × 11″ Bulletin No. 750 describes and illustrates "Type U" 5-range Universal type hand tachometer imported from Switzerland. Included also are: advantages, instructions for use, principles, and a table showing standard range combinations. Herman H. Sticht Company, Inc., 27 Park Place, New York, N. Y.

N-6 **Automatic Feeder for Control of Deep-hole Drilling of Small Holes.** 4-page 8½″ × 11″ Bulletin M1-10M pictures and describes "Pre-Selectric Power Feeder" which automatically duplicates operations of skilled mechanic when deep drilling or tapping small holes without danger of breaking drill and with less dulling. Shown also are installation and operating illustrations. James H. Knapp Co., 4920 Loma Vista Ave., Los Angeles 11, Calif.

N-7 **Rotameter for Handling Large Flows.** 2-page 8½″ × 11″ Bulletin No. 82-A pictures and describes "Rotasleeve" rotameter built to handle larger flows than the conventional types. Featured are other indicating, recording and controlling and integrating rotameters. A table giving sizes and capacities of "Rotasleeves" manufactured is also included. Fisher & Porter Co., Hatboro, Pa.

N-8 **The Hydromike.** 4-page 8½″ × 11″ September 1945 issue No. 25 of this house organ features bits of news and shorts such as: "A Humormometer," "How Well Can You Concentrate," "Porcelain Enameled Iron Staff Gages," "More about Calendars" and letters from readers. Leupold & Stevens Instruments, 4445 N. E. Glisan St., Portland 13, Oregon.

N-9 **Electric Soldering Irons.** 4-page 8½″ × 11″ folder pictures and describes three types of irons namely: screw tip, plug tip and hatchet, and features various sizes available and applications of each. Hexacon Electric Co., Roselle Park, N. J.

N-10 **Balancing Ways.** 2-page 8½″ × 11″ bulletin pictures and describes a static balancing mechanism with "scale type" bearings. An accuracy to 0.0007 ounce-inches is said to be possible in 10″ size. The Ideal Commutator Dresser Co., Sycamore, 1420 Park Avenue, Sycamore, Illinois.

N-11 **Volt-ohm-milliammeter.** 2-page 8½″ × 11″ Form 71045-T pictures and describes "Model 625-N Volt-Ohm-Milliammeter" that has a lifetime guarantee against defective workmanship or material. D-c. voltage ranges with dual sensitivity (10,000 and 20,000 ohms per volt) are said to provide for double the number of full-scale readings the average tester gives. Triplett Electrical Instrument Co., Bluffton, Ohio.

N-12 **Flight Hour Meter.** 2-page 8½″ × 11″ bulletin pictures and describes an instrument that registers number of hours and minutes of actual flight. The bulletin also describes an air operated switch which starts and stops flight hour meter. John W. Hobbs Corp., Springfield, Ill.

N-13 **Tubing Service Tools.** 16-page 3¼″ × 6¼″ Folder No. 347 describes and illustrates various tools used with copper, brass, aluminum, thin-wall steel or similar tubing: tube cutters, tube benders, coil makers, swedging, pinch-off and reaming tools; also soldering equipment and a number of tool kits. Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.

N-14 **Snap Gage with Built-in Indicator.** 4-page 8½″ × 11″ Form A-313-

10-7-45 describes and illustrates various models of gages that indicate dimensional variations on an easily-read dial graduated in 0.0001". "Model 1340" is described in detail. Federal Products Corp., 1144 Eddy St., Providence, R. I.

N-15 **Tungsten Carbide Gage Blocks.** 2-page 8½" × 11" bulletin features gage blocks that are said to be 100 times more resistant to abrasion than steel and 98 times more than chrome-plated blocks. Included also are specifications and characteristics of tungsten-carbide blocks. Fonda Gage Co., 53 Daly St., Stamford, Conn.

N-16 **Polarizing Microscope.** 4-page 7" × 10" folder pictures and describes "No. 42" polarizing microscope with optical system that contains polaroid material in place of usual calcite polarizing prisms. Also included are: photographs of the necessary case showing standard equipment with this instrument, substage condenser with string-out unit tilted, and a centering nosepiece. Spencer Lens Co., Buffalo 11, New York. Scientific Instrument Div., American Optical Co.

N-17 **The Laboratory.** 44-page 6" × 9" issue of this house organ (designated as Vol. 15, No. 5) contains pictures and information on latest developments of laboratory apparatus and technique. Some of the topics included are: (1) "Battle of the Laboratories," (2) "Science Contributes the Atomic Bomb," (3) "Other Laboratory Contributions to Victory," (4) "Magnetic Principle Utilized to Stir Liquids in Closed Vessels," (5) "A Better Laboratory Paint Now Available." Fisher Scientific Co., 717 Forbes St., Pittsburgh, Pa.

N-18 **Spectrographer's News Letter.** 4-page 8½" × 11" August issue (designated 1, No. 12) of this house organ features two articles: "A Versatile Two-meter Spectrograph," and "Arl-Dietert Film Calibration and Intensity Control Stand." Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Mich.

N-19 **Inter-communication System.** 8-page 8½" × 11" folder illustrates and describes the "Temporator," explains the transmission capacity, method of transmission, what it does and how it does it and its adaptability. Simplex Time Recorder Co., Gardner, Mass.

N-20 **Paper Testing Instruments.** 20-page 6" × 9" Bulletin No. 1420 describes and illustrates the following paper testing instruments and explains their applications, size, etc.: Densometers, automatic timing attachments, Gurley-Cobb sizing tester, smoothness and stiffness tester, and Gurley-Hill S-P-S Tester (measures softness, porosity and smoothness of papers). W. & L. E. Gurley Engineering Instruments, 514 Fulton St., Troy, New York.

N-21 **Motor-driven Dry Air Pumps.** 4-page 8½" × 11" folder (designated as Check Chart No. 17) describes the Eclipse explosion-proof light weight (4.75 lb), motor-driven, dry air pump which is said to provide air pressure absolutely free of oil contamination, requires no lubrication, have flexibility of installation and wide range of application. Eclipse-Pioneer Div. of Bendix Aviation Corp., Teterboro, New Jersey.

N-22 **Force-balance and Position-balance Control Mechanisms.** 8-page 8½" × 11" reprint of an article in *Instruments* makes comparison of force-balance and position balance control mechanisms. Eight schematics and 11 pictures are included to clarify this comparison. Cochrane Corp., Philadelphia, Pa.

N-23 **Nullmatic Remote Manual Control.** 4-page 8½" × 11" Bulletin 401 pictures and describes the precision remote manual control used for remote setting of automatic controllers for air-operated valves, dampers and pistons. This manual control panel includes the "Nullmatic" pressure regulator, which is said to hold set values constant regardless of wide changes in flow or in supply pressure. Specifications, performance data, description, and the principles of operation as well as a cut away drawing, showing the various parts that make up pressure regulator are included. Moore Products Co., H & Lycoming Sts., Philadelphia 24, Pa.

N-24 **The Story of Research.** 22-page Booklet 50 M., GEB-113 tells of this company's history, research activities and its contributions to American progress. It features an article "New Lamps for Old" (traces development of Edison's lamp to uses it has been applied and designed for today). General Electric Co., Publicity Dept., Schenectady, N. Y.

N-25 **Radio and Electronic Supplies.** 48-page 5¼" × 8¼" Sept. 1945 "Availability List" lists radio and electronic supplies as well as various electric counter switches, signalling devices, batteries, flashlights, phonograph record changers, work benches, transform-

New Comparator Gage Saves Time
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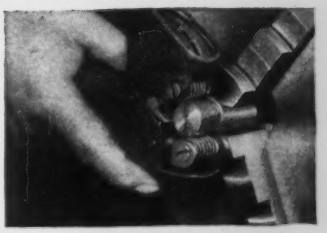

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